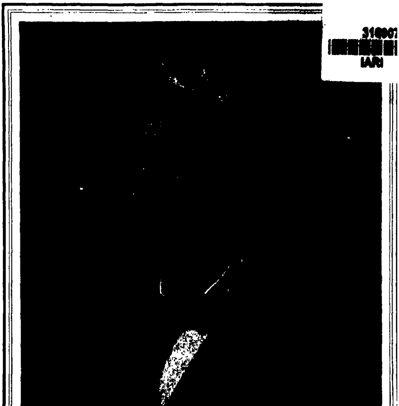
SCIENTIFIC AMERICAN

JULY 1927 *Thirty-five Cents a Copy*



THOMAS ALVA EDISON

SUPER-GUNS FOR OUR ARMY

BY J. BERNARD WALKER

SEEING THE EARTH TURN

SUNBURN IN THE DARK

SCIENTIFIC AMERICAN

July 1927 *Edited by* ORSON D. MUNN Eighty-third Year

FLIP-FLOPS

WELL—here it is: the new SCIENTIFIC AMERICAN; how do you like it?

We have decreased somewhat in over-all acreage, but we are a little bulkier to make up for it—more magazine, as a matter of fact, and in a little different shape.

We wonder whether you realize how much of a job it has been to get ready this new format? We shan't go into all the nightmare of details here—it would require a whole article in itself; yes, more than that—but you may take it on faith that there is much more to it than meets the eye. Planning, planning, wrestling with styles and sizes of type, layout, makeup. Our layout editor has been doing flip-flops over it ever since January.

Now that it is all finished we are going to sit back and await the reaction. If you are satisfied with our efforts, we are more than repaid.

As we said at the beginning, how do you like it?

EDISON

THE impossibilities of yesterday are the commonplaces of today. Our lives are brighter, happier, longer, more effective than those of our fathers. The swift-moving era in which we live is the most wonderful the world has ever known. In the last fifty years greater progress has been made than in all the five thousand years of recorded history which went before. Here is the golden age of invention, and so it will be written in the annals of time.

In the career of one man we find the genius of the age expressed. The story of his life—from boyhood poverty to affluence and veneration in his declining years—epitomizes the opportunities which lie in our democracy. The story of his achievements—including more than a thousand patented inventions—is the very flower of our civilization.

The world is a better place because the wizard of electricity has lived and worked. We feel honored that so great an American has loaned us his portrait that we might reproduce it this month on our cover.

ERROR

IN the May SCIENTIFIC AMERICAN the frontispiece was a picture of Professor R. W. Wood of John Hopkins University, noted physicist. Under this picture we stated that Professor Wood's book, "Physical Optics," was out of print. We have since found out that our informant was wrong—the book is still in print and is published by the Macmillan Company, New York. We are glad to know that "Physical Optics" is still available, because we like it best of all the books on that subject, and recommend it to those who wish to dig into optics.

CONTENTS

JULY 1927

DEPARTMENTS

PLATINUM

ON page 52 we publish the first installment of an article about the famous Meteor Crater in Arizona. Meteor Crater resembles two things: an ordinary volcanic crater and an enormous shell-hole. Some say it *is* a volcanic crater, especially since there are evidences of extinct volcanoes in Arizona. Others claim it is actually a giant shell-hole made by an iron meteor which struck the earth and buried itself deep in the rock.

Meteor Crater is not news—articles about it have appeared in Sunday newspaper supplements for years. Writers have embroidered the description with wild conjecture. The article we now publish is the only first-hand description which has ever been published. It was written by the son of the owner of the Crater. The author is a mining engineer now employed as geologist for a mining company whose name is a by-word the world over. What he says may cause you to revise some of the impressions created by previous erroneous statements about Meteor Crater.

Scientists estimate that the meteor contains 10,000,000 tons of nickeliferous iron in lump form. If the belief that this iron will average *four tenths of an ounce of platinum metals per ton* turns out to be true, then Meteor Crater is something worth thinking about.

Within a short time a shaft will be sunk near the point beneath which the great meteor is believed to lie. We are holding our breath!

LINDBERGH

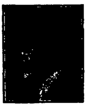
THE brevity of this reference to Lindbergh's superb, one-man flight from New York to Paris is due to the fact that we were just going to press when the flight ended. We would have liked to give several pages to a description of the plane, the engine, and the man. Audacity, courage, and skill such as his have ever made a supreme appeal; but when to these is added a natural modesty, it is easy to understand the world-wide applause which acclaimed this gallant youngster. It was sheer audacity to set out with little knowledge of navigation, but the elements were kind, and in less than 34 hours, Lindbergh crossed the Atlantic.

Among our Contributors

DR. D. T. MacDOUGAL

Dr. MacDougal, well-known botanist and author, is director of the two plant-physiology laboratories of the Carnegie Institution of Washington, one in California, the other at Tucson, Arizona. Between these two he makes frequent trips in a steam-driven automobile. He is a member of the famed National Academy of Sciences and is influential in scientific circles. For several years he has been corresponding editor of the SCIENTIFIC AMERICAN. His most recent work bears on the unsolved problem of the nature of life.

DR. ALFRED V. KIDDER



Dr. Kidder has spent virtually his whole life on the archeology of the Southwest, making explorations and excavations. He has been curator of North American Archeology at the well-known Peabody Museum of Harvard University. For several years he conducted excavations at Pecos, New Mexico, for Phillips Academy, Andover. At present he is excavating under the aegis of the National Research Council.

Russell W. Porter

SCIENTIFIC AMERICAN readers know him for his contributions on amateur telescope making. Originally an architect trained at Boston "Tech," he spent twelve years with Peary and others in the Arctic. Co-inventor of the screw-thread comparator, in spare time he is an artist, composer and corresponding editor of the SCIENTIFIC AMERICAN.

Orrin E. Dunlap, Jr.

Mr. Dunlap is our radio editor. Since 1922 he has also been radio editor of the *New York Times*. A member of the Institute of Radio Engineers, he was formerly a Marconi and United States Naval operator. He is a graduate of Colgate University.

Prof. P. W. Bridgman

Professor Bridgman belongs to the Department of Physics at Harvard. One of our editors recently visited him and found him in working clothes in the cellar of the physics laboratory, trying to find a way to exert still higher pressures than those which will stagger the readers of the article commencing on page 43.

D. Moreau Barringer, Jr.

Mr. Barringer is assistant geologist for a famous copper mining company. His father, D. M. Barringer, is the owner of Meteor Crater, Arizona, and has collaborated with his son in the preparation of the engrossing series of articles which begins with this issue, commencing on page 52.

Looking Ahead *with the Editor*

TORNADOES

The fact is, little has yet been discovered about the cause of tornadoes. Next month Dr. W. J. Humphreys, foremost Weather Bureau authority on the physics of the air, will present his theory.

TACT

What *is* "social intelligence?" Briefly, it helps you to get along with other people. It makes "college graduates" of unschooled politicians in the race for preferment. Prof. F. A. Moss, psychologist, has tested the social intelligence of 7000 persons. His article about these tests contains surprises. Next month.

TELEPATHY

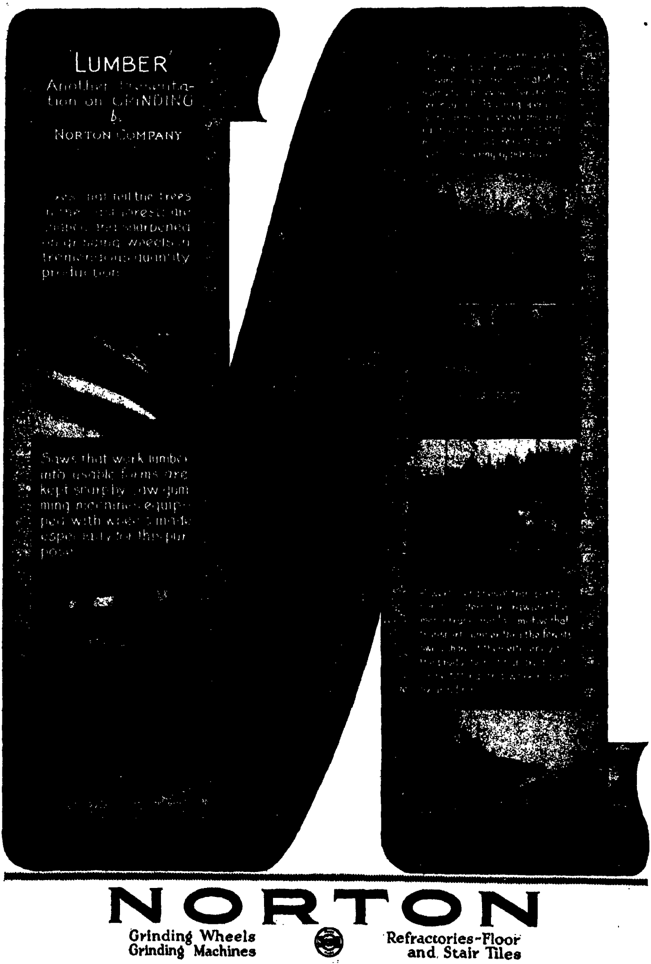
Spring this question in any group—you have an argument on your hands at once. It is a subject everybody is interested in. In an early issue Dr. Walter Franklin Prince, famous investigator of psychic phenomena, will provide some "meat" for these heated oral battles.

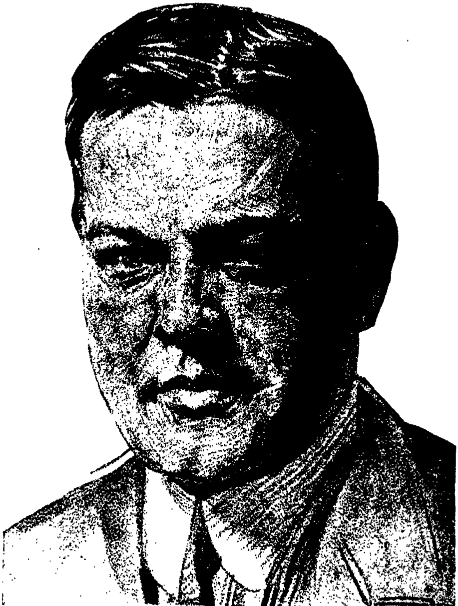
ATHLETICS

With college men in science and college men in athletics it is odd how little the one has been applied to the other. Next month, however, a famous physiologist who also enjoys sports will describe some of these applications. He finds that a runner is virtually a machine.

GOLF

Golf clubs designed by following mechanical engineering principles offer the player an opportunity to improve his game vastly. A well-known scientist will tell of his dissatisfaction with existing clubs and how he designed an entirely new type.


LUMBER
NORTON COMPANY
NORTON
Grinding Wheels
Grinding Machines
Refractories-Floor
and Stair Tiles



From a Photograph © by Underwood and Underwood

The industrial life of America and the health and well-being of our people are clearly dependent on future applications, by engineers and physicians, of new discoveries in the physical and biological sciences. If we are to go on increasing our population we must either advance in scientific discovery or we must recede in our standard of living. Of even greater importance, however, is the advance of human thought, the stimulation to the human mind which comes from the advance of science, and publications such as the SCIENTIFIC AMERICAN *which pass on to the thinking public the truths our intellectual leaders have uncovered, are rendering a public service whose value cannot be over-estimated.*

Herbert Hoover

Multiple Mount of Four .50-Caliber Machine Guns

The Bureau of Ordnance, under General Williams and his brilliant staff, has spent the post-war years in developing new ordnance material (guns, mounts, fire-control, motorized tractor mounts, aircraft bombs, et cetera,) that shows an average increase in efficiency of one hundred percent or more over the ordnance with which we entered the war. Indeed, the .50-caliber machine gun, shown in the above illustration, is four times as effective as the old .30-caliber machine gun.

ARMY COAST-DEFENSE 16-INCH GUN

Super-Guns For Our Army

Ordnance Officer, Chemist and Mathematician Combined Have Doubled the Efficiency of Our Army Ordnance Since the War

By J. BERNARD WALKER

ONE of the most important, if not indeed the leading factor in the defences of the United States, is the large and highly efficient Proving Ground at Aberdeen, Maryland, which has to do with the development of new and improved types of ordnance and acts as the great testing plant in which the guns that are issued for service are thoroughly tried out. "Its responsibility to the War Department is to design, develop, procure (which includes both purchase and manufacture), test for acceptance, store and issue, maintain and repair, both in the hands of troops and in storage, all army ordnance. Also, it is charged with the training of our Reserve Ordnance Officers."

BEFORE our entrance into the World War, and indeed until January, 1918, most of this work was done at the Sandy Hook Proving Ground. The war had not progressed very far, however, before it was realised that the facilities at Sandy Hook would be inadequate and that a much greater area of land and a larger plant would be necessary to keep pace with the huge ordnance manufacturing program which was contemplated.

So the present site at Aberdeen, Maryland, which is about midway between Baltimore and Philadelphia, was selected. It is accessible to the principal industrial centers; weather conditions are favorable throughout the year, and it was possible to take up an area of adequate size, and sufficiently remote from surrounding communities to let the work of testing go on without danger. The Proving Ground is on the northwest shore of Chesapeake Bay. It covers about 35,000 acres; its maximum width is some four miles and its maximum length 15 miles. The work of testing commenced in January, 1918, and it expanded so rapidly that, just before the Armistice, as high as 70,000 rounds per month were being fired on the grounds.

The main firing platform has an unobstructed range of as high as 30,000 yards. The railway and sea-coast artillery firing ground is so located that there is a clear range up to 30,000 yards in front of it, and a water range down an adjacent stretch of the Chesapeake extending 60,000 yards. The fall of the shell on these water ranges is observed from 12 range towers, built at intervals along the shore of Chesapeake Bay. Intersecting sights taken from these towers of the splash of the falling projectile give its exact position and enable the range to be accurately determined. The Proving Ground plant also includes apparatus for testing tanks, tractors and the new heavy, driven, gun-mounts. Furthermore, there has been built since the Armistice a firing range for the testing of small arms, machine guns, et cetera, and a certain area has been set apart for the testing of bombs, bomb-sights, and so on. To assist in this work, there are permanently stationed at the Proving Ground certain squadrons of flying men.

THE present article is a story of the really marvelous development in the efficiency of ordnance which has been made possible through the work of the Ordnance Department in general and the Proving Ground in particular. After the Armistice, an immediate halt was called upon the prodigious output of guns and powder for the supply of our Army and those of the Allies, and, as soon as the guns then under manufacture had passed through the Proving Grounds successfully, the activities at Aber-

NEW 4.7-INCH GUN

At maximum elevation has range of 20,050 yards, traverse 60 degrees. Wartime gun, range 14,060 yards, traverse 8 degrees

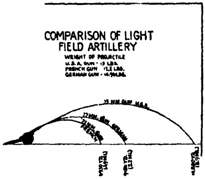
THE FIRE DIRECTOR

This remarkable machine automatically determines the height, range and speed of enemy aircraft and transmits data to battery

deen quickly and inevitably slowed down. At the Armistice, the personnel comprised 272 commissioned officers, over 4,000 enlisted men and 1,200 civilian employees, to say nothing of 3,000 men employed on the construction of the plant. This personnel was finally cut down to 40 officers, 250 enlisted men and 375 civilians.

In the interval from 1918 to 1926, the staff has devoted itself to the development of new types of ordnance that should greatly exceed in range, power, accuracy and mobility, the best of the ordnance that had been developed by ourselves and the enemy during the War. We do not hesitate to say that the resulting post-war artillery constitutes one of the greatest triumphs in the whole modern field of mechanical engineering. This is a strong statement; but, remembering the great complexity and difficulty of the science and art of gun design and development, it is sufficient to look at the accompanying drawings and their descriptive captions to realize that the statement is not an exaggeration.

FOR the photographs, diagrams and general information contained in this article, we are indebted to the courtesy of Major General C. C. Williams, Chief of Ordnance, Washington, D. C., Lieutenant Colonel C. M. Wesson, Commanding Officer at the Proving Ground, and their respective staffs, and to the descriptions of our country's progress in artillery as recorded from month to month in that excellent publication *Army Ordnance*. To this data we have added our personal impressions gathered



during several visits to the Army Proving Ground.

Ordnance is a term applied generically to implements of war which may range all the way from the delicate parts of a time-fuse up to the massive forms of a 16-inch gun and its mount. As an instance of delicate and highly specialized work of this kind, take the case of fuses of the shells of anti-aircraft guns.

As airplanes went higher, it was found that the old powder-train fuses, because of the changing atmospheric pressure and the failure of the train to burn at a uniform rate, were inaccurate. Therefore, the ordnance officers called in the watchmaker to design a mechanical time-fuse. There was developed a mechanism far more delicate than a high-grade watch, but sufficiently rugged to stand the shock of firing from a high-velocity gun, and being whirled around with the shell at 30,000 revolutions per minute. Consider, also, the investigation to determine the proper shape to give the bullet its highest velocity.

It was desired to take photographs of a .30-caliber bullet moving at 32,400 inches per second, and it must be remembered that, even with an exposure of only 1/32,400 of a second, the bullet would move one inch. The time had to be cut down. By using an electric spark and by damping the discharge, the time was reduced to one ten-millionths of a second and a sufficiently sharp photograph was secured. The air "bow wave" and the "wake," or partial vacuum back of the bullet, were clearly shown, and out of this investigation came a bullet, with a long pointed nose and a "boat tail" after portion, which gave the best results and added unbelievably to the range of a bullet using the same charge of powder.

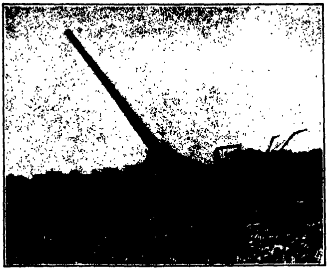
As a result of this investigation the range of the bullet was increased from 3,500 to 5,700 yards, and this was done without changing the cartridge case or the gun.

BECAUSE of the tremendous air blast, the camera could not be used for large projectiles. Here the higher mathematics of the astronomer were called in to solve the problem. These computations, coupled with many experiments in the wind tunnel, gave a six-inch projectile with a range, from a greatly improved, gun, of

NEW 155-mm. GUN ON NEW MOUNT

EIGHT-INCH HOWITZER ON NEW MOUNT

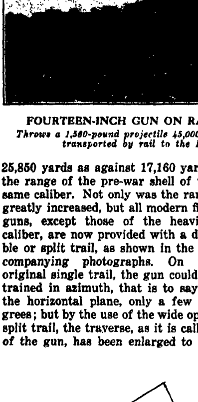
Throws 200-pound shell 18,700 yards. Range of wartime howitzer 12,400 yards. New 155-mm. gun uses same mount



FOURTEEN-INCH GUN ON RAILWAY MOUNT
Throws a 1,560-pound projectile 45,000 yards. This gun was transported by rail to the Pacific Coast

THE 16-INCH GUN IN THE SHOPS
This dramatic picture shows the gun at high elevation. Note the scale afforded by men standing by

25,850 yards as against 17,160 yards, the range of the pre-war shell of the same caliber. Not only was the range greatly increased, but all modern field guns, except those of the heaviest caliber, are now provided with a double or split trail, as shown in the accompanying photographs. On the original single trail, the gun could be trained in azimuth, that is to say in the horizontal plane, only a few degrees; but by the use of the wide open, split trail, the traverse, as it is called, of the gun, has been enlarged to the



extent shown in the accompanying line drawing.

The vast increase in the area which can be covered by a single gun has rendered the modern piece an enormously more potent weapon than the type which was used in the World War.

The metallurgist has fulfilled his part, and a very important part it has been, in the development of our post-war artillery. By the development of a suitable alloy steel, and subjecting it to suitable heat-treatment, guns of much greater caliber-length, able to withstand higher powder pressure, have been provided. Hence the increased ranges mentioned above have been obtained without any increase of weight or loss of mobility of the gun—an important consideration.

Another notable improvement in mobility has been secured by mounting guns up to 9.5 in caliber upon motor-driven caterpillar mounts. This development, it is true, began before the close of the war; but since the Armistice, it has been carried to such a point of efficiency that by the judicious use of rubber with its consequent reduction of shock and saving of energy, the speed of the smaller units has been raised from five miles per hour up to, in some cases, as high as 30 miles per hour. Moreover, the engines have been waterproofed and the tractive effort has been so greatly increased, that the tractor can be driven through water and the tractor-mounted gun can climb a 45-degree grade without difficulty. The maneuvering ability in fact has been developed to a point "where no human being could dodge it in an open field."

We do not know what the other artillerists throughout the world have been doing during the past nine years; but, in view of the great advance which has been shown at Aberdeen, it is reasonable to believe that we can, today, at least hold our own and probably surpass the artillery performance of any foreign nation.

NOW, let us turn our attention to the shoulder rifle—the great weapon of the infantryman. Even before the commencement of the World War, our "Springfield" was probably the finest regulation army rifle to be found anywhere in the world. It is stated on official authority that during the war, allied soldiers would "pick up and cherish our Springfields whenever they found one on the field of battle."

The Springfield, of course, was hand-operated. Between each shot, the infantryman had to go through the operations of lifting the bolt, withdrawing it, pushing it forward, and pulling it down and locking it—all these movements having to be gone through before the next aimed shot. This prevented the sight being held continuously on the target. To enable this to be done, there was developed the semi-automatic shoulder rifle, which automatically ejects the empty shell and places another cartridge in position. Today, all the rifleman need do is to hold his sights on the target and pull the trigger.

The automatic machine gun, which is used when it is desired to pump a stream of lead over enemy troops or at an enemy position, was, of course, developed long before the war; but like every other weapon, it was improved during and since the war, and the Browning machine gun represents, in the opinion of our artillerists, the highest development of machine guns of the .30-caliber type. But, the great demand made upon the machine gun by aerial combat and by anti-aircraft gunners, led to a demand for a larger caliber with greater range and accuracy. Hence, since the war, we have developed the .50-caliber machine gun,

NEW 3-INCH ANTI-AIRCRAFT GUN

Fires 27 aimed shots per minute to a height of 25,000 feet and with a range of 6 miles

NEW FULLY-AUTOMATIC 37-mm. GUN

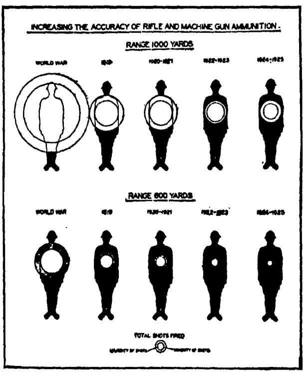
Fires a 1¼-pound explosive projectile at a rate of 120 shots per minute. Range 1⅛ miles

which throws a bullet four times as heavy and three times as far as that of the .30-caliber Browning gun.

Limitations of space prevent more than a brief reference to the development of airplane bombs. At the Armistice, a bomb weighing 500 pounds was considered powerful; but today the large army planes can carry a bomb of 4,000 pounds containing a ton of high explosive. The size of the individual bomb is today governed by the lifting ability of the airplane.

Returning to the matter of motorized artillery, the experts of the Ordnance Department have this to say:—"When the Ordnance engineer mounted his new long-range 'Seventy-Five' directly on the new 15-mile-per-hour caterpillar tractor, he blazed the way for artillery development of the future." This development is one of the outstanding features of the ordnance developed since the war. There is no question that automotive transport will ultimately displace horse-drawn transport; for motor transport is cheaper; its gas and oil are less bulky than forage; it requires fewer men to operate; it is easier to ship; it occupies less space on the march; never grows weary; is less vulnerable than horse-drawn transport; it is more sanitary and, a most important point, it can be camouflaged more easily.

WE heard much about the .155-(6-inch) gun during the war. The post-war piece of this caliber outranges the World War piece by nearly five miles. It has been mounted on a caterpillar tractor which can carry it at a speed of 15 miles per hour; it can climb a 45-degree grade, and can ford rivers and streams. The limit of such mounting has been reached in the 9.5-inch howitzer and this heavy piece—thanks to skillful distribution of weight—exerts a ground pressure per unit of area no greater than the pressure due a man standing on one foot. And, by the way, due to its great mobility, the motorized artillery, even of the great weight of the 9.5 piece, can be moved quickly, as soon as its position has been located by the enemy. With automotive artillery, a number of positions can be selected in advance, firing data computed for each, and at the proper time, the self-propelled mount can move to each position in turn, fire a few rounds (the engine meanwhile running) and before the enemy battery locates its position, it can pull out and move elsewhere.



THE RIFLE'S DEADLY ACCURACY

Tests made with rifle rigidly clamped in a mechanical rest. No trained sniper, of course, could equal this record

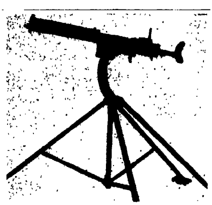
The development of tanks at the Proving Ground can be fully appreciated only by one who, like the writer, has had the opportunity to study them in action on ground selected for its roughness. The celebrated Mark VIII—a joint British-American design—remains the standard; but it has been rendered more efficient by many improvements, conspicuous among which is the stroboscope which is carried in a cylindrical sighting turret on the roof of the tank. This is provided with narrow, vertical slits and a concentric vertical, rotating cylinder. By this arrangement, the officer is well protected by armor and yet has a practically clear and continuous vision.

NO article describing Aberdeen would be complete that failed to mention the wonderful development in anti-aircraft artillery. We have spoken already of the great post-war increase in the range of the anti-aircraft .30-caliber machine gun and of the even more striking increase of power and range of the anti-aircraft .50-caliber gun. Although the bullets from these will reach and perforate the fabric of an airplane and may, once in a while reach the aviator himself, it was proved in the World War that a machine could come back, with its wings and fuselage heavily perforated with bullet holes, and yet be perfectly manageable. Evidently, something larger than a bullet hole was necessary, and hence the Aberdeen artillerists have developed a wonderful little gun—the light 37 mm.—which has great rapidity of fire, great range, and carries a fuse so sensitive that it is detonated even by the faint resistance offered by the fabric of an airplane wing.

Not only do its bursting shells tear a large hole in the fabric, but the fragments will be scattered like those of a shrapnel shell.

THE anti-aircraft 3-inch gun—thanks to a new system of director-firing and generally improved mechanism—is a vastly more effective piece than that of 1918. The progress in the work of improvement has been continuous and is still going on. Thus, at a test at Fort Tilden in 1925, with 3-inch wartime guns, ten shots were fired per gun per minute, at a sleeve target towed at 80 miles per hour at a range of 4,000 yards; and 5 percent of hits were secured. In the following year, 1926, the latest 3-inch guns were tried out at a similar target towed at 80 miles per hour at about 5,000 yards range. The average rate of fire was 22 rounds per gun per minute, and the average hits reached an average of 12 percent. Not only has the rate of fire of the anti-aircraft machine gun been increased, but as many as four machine guns are being placed in a new multiple mount which means that if each gun is capable of, say, 500 shots per minute, the man at the trigger can deliver a stream of 2,000 shots per minute against an airplane. The new "director," a photograph of which is herewith reproduced, makes it possible for the officers who operate it to determine the speed of an airplane, its elevation, changes of course, et cetera, and send this data by connecting cables to every gun of a battery. Carried upon the gun mount are electric motors which, in response to the electrical impulses from the tractor, give the gun changes of elevation and traverse necessary to insure that shell and airplane will meet at a predetermined position in the heavens. The vertical range of the 3-inch and of a new 4-inch gun of high velocity is such that no existing airplane can rise beyond its reach—all of which means that the airman of the future is going to have a pretty hot time of it when he passes over the terrain occupied by the forces of the enemy.

A word must be said about the great guns which have been developed for coast defense and which will be either emplaced in fixed fortifications or will do their firing from railway mounts traveling upon strategic railways located along the coastline. Guns too heavy for transportation by tractor are carried upon what are known as railway mounts. The latest models



BROWNING .50 CALIBER MACHINE GUN

This water-cooled gun far exceeds the .30-caliber gun in range and height of trajectory

can transport both the 14-inch .50-caliber gun and the 16-inch high-angle fire howitzer. The 14-inch gun can hurl a 1,560 pound shell for 45,000 yards, and the 16-inch howitzer throws a 2,340 pound shell 55,000 yards. These railroad mounts have given our heavy artillery a wonderful mobility. The 14-inch gun, here shown, was transported by rail from the Atlantic to the Pacific coast.

The heavy, long-range gun, on railway mount, will undoubtedly play a great part in future coast defense. Its potentialities were shown in the Turkish defense of the Dardanelles, where heavy pieces, shifting continually from place to place along the shore, proved very baffling to the attacking ships of the allies. The weakness of fixed defenses, such as the forts which defend the entrances to our leading ports, lies in the fact that their exact position is known, and when the heavy guns have been located by their flash and by airplane observation, they may be subjected to accurate and sustained long-range bombardment.

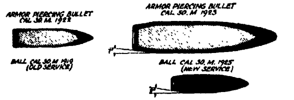
The heavy gun, rail-mounted, is subject to no such disadvantage. The military tracks for such artillery would be located near the coastline; but they would be so placed as to take advantage of the cover offered by the natural features of the ground, such as bluffs, woodland, sand dunes, etc. Upon its location by the enemy, the gun would be moved over the rails to a new site from which it would open up on the enemy with little delay.

THE most powerful gun in the country today is the 16-inch, .50-caliber gun, which can hurl a 2,340-pound projectile over 55,000 yards. This weapon is more powerful and has a greater range than any gun now mounted, either ashore or afloat. Its armor-piercing shell, by the way, will penetrate 14 inches of face-hardened armor at any range.

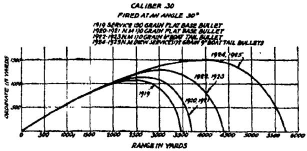
Just here let it be said that the Aberdeen Proving Ground represents the most effective means of preparedness available under existing conditions in the United States; since, by providing standard ordnance of the very highest quality and preparing sets of jigs for each weapon, the War Department, in the event of war, will be able at once to start the vast industrial plants of the country upon the task of manufacturing the necessary ordnance, without the intolerable delay which occurred when we found ourselves suddenly enlisted in the World War.

Says Mr. D. M. Edwards of The National Association of Manufacturers: "Should war unhappily come again, it will be won by masses of men at the front and the massed intelligence of industry back of the lines. Had our nation been as well equipped when it entered the war as it is today, instead of taking eight or nine months to get into action, it would have meant the saving of a million or more lives and millions of dollars worth of property."

CALIBER .30 AND CALIBER .50 BULLETS



TRAJECTORIES OF NATIONAL MATCH BULLETS



Watching the Earth Turn Over

The Famous Pendulum Experiment which Makes Visible the Earth's Rotation May be Performed with Simple Apparatus

By RUSSELL W. PORTER
Optical Associate, Jones and Lamson Machine Company

NCE in a great blue moon you will run across someone who believes that this old earth of ours is fixed rigidly somewhere in space, and that what we see in the heavens—the sun, moon, stars and planets—is circling about us. And I fear some of us would be hard put to it to prove that our globe, and not the other objects, is doing the rotating.

A pretty strong argument against a non-rotating earth would be this: were we immovable in space, the more distant stars would have to revolve faster than those nearer to us, in order not to change their relative positions in the heavens. But we now know enough of star distances to make any such assumption at least highly improbable.

Apart from any astronomical considerations, there are at least three proofs of the earth's rotation. As far back as 1697 Newton suggested that an object dropped through a great distance—in this case a mine shaft—should strike the bottom a little east of a point directly beneath the point of projection, because the top of the shaft is moving more rapidly than the bottom. In the 500-foot drop available the theoretical deviation was about an inch. And the means of a large number of trials was in fair agreement with this theoretical value.

Let Us Hear From You

Following numerous requests we publish definite specifications for constructing the apparatus needed to perform the famous Foucault pendulum experiment. Such information has always been relatively hard to obtain. The author of the accompanying article has, however, both constructed the apparatus and made the experiment. Mr. Porter has been in turn polar explorer, architect and inventor, and is now attached as Optical Associate to a famous industry. It was he also who fathered the *Scientific American* amateur telescope making campaign. If you perform the experiment please advise us how it worked out. *The Editor.*

Another proof depends on the property of the gyroscope of maintaining the direction of its axis invariable in space (unless acted on by disturbing forces). Consequently the earth will appear to rotate under the gyroscope.

The experiment to be described here is, however, that of the simple pendulum. The man to whom we are indebted for this demonstration that the earth turns over, was that wizard of the last century (1819-1868), Leon Foucault. Not only did his remarkable ingenuity in experimental physics give us a fundamental proof of the earth's rotation, but also a determination of the velocity of light and a priceless method of testing optical surfaces, one application of which was described recently in the SCIENTIFIC AMERICAN in connection with the making of mirrors for reflecting telescopes.

The consideration which led Foucault to perform his famous experiment was simply this: a perfect pendulum will continue vibrating in space in the direction in which it was originally set swinging, independent of any rotation of its support about its point of suspension. Therefore the earth will be seen slowly turning beneath the pendulum, just as in the gyroscope experiment. Not only does it

show the fact of the earth's rotation, but its direction. To one looking down on the northern hemisphere this is counter-clockwise; or, as we ordinarily state it, the earth turns from west to east.

When he performed his classic experiment, 75 years ago, Foucault hung his pendulum from the dome of the Pantheon in Paris. The suspending wire was nearly 200 feet long and the ball weighed about 80 pounds. As the pendulum swung back and forth, the needle which projected from the bottom of the ball traced its path in a tray of sand. And the *tray* was seen to turn!

The announcement made a profound impression on the scientists of the time, as it provided a proof of the earth's rotation, independent of any astronomical observations.

This famous experiment is referred to in all textbooks of physics, but with a total disregard to the practical details necessary to help the fellow who wants to do it himself, and it is this lack of definite information that prompts the present article.

I recently constructed a Foucault pendulum, and when it became known in the large industrial organization with which I am associated here in Springfield, that "Porter had a 'thing-umbob' in his office that showed the earth turning over," I was besieged by the mechanics in the shop, who came to me asking to be shown.

The demonstration gave quite a little thrill. It is so simple that the men all grasped its significance, and they would go away shaking their heads, saying, "Well, I'll be darned."

VISUALIZING THE EXPERIMENT

When performing it one has an uncanny sense of personal detachment from the earth

MY pendulum is about twelve feet long, and is hung from a steel I-beam in the ceiling. I used piano wire, and a cast-iron ball weighing perhaps 40 pounds. The effects of air resistance are reduced as we increase the length of the pendulum and the weight of the bob. Lead naturally makes the most efficient bob, but any heavy mass will do. In time, of course, the pendulum slows up, but with a three-foot initial swing my bob will still be swinging through two feet amplitude at the end of half an hour —ample time to see the rotation, which becomes apparent even after a few moments.

The pendulum must be hung from a solid support free from vibration (I have trouble when the shop machinery is running), and the air in the room must be free from drafts.

To free the pendulum from any tendency to twist I fastened to the wire a brass hook having very much the shape of an interrogation point (see drawing). The point of the hook rests in a shallow cup of steel screwed into the I-beam. The concave surface of the cup was carefully lapped smooth in a lathe, with fine emery.

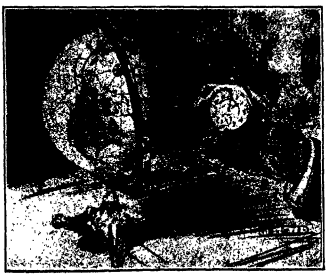
In making the experiment it is important that the bob be completely at rest before it is started swinging. To assure this the ball is drawn back with a string and, after coming to rest, the string is burned. Unless this precaution is taken the bob will tend to swing in an elongated ellipse, and any slight "looping" at the start will become aggravated as the swinging continues.

It does not matter in what direction the pendulum is set swinging. In the accompanying sketches I have depicted it swinging north and south, that is, in the meridian. However, this was done merely for clarity.

The pin or needle protruding from the ball should just clear a sheet of cardboard on the table. Draw a straight line across the cardboard and move it on the table until the line lies in the vertical plane with the path of the swinging needle.

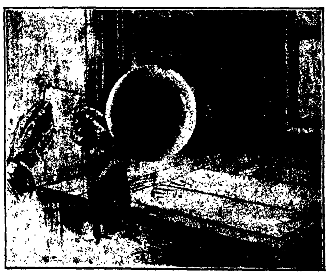
Now watch the line on the cardboard—or the southerly end of it. In a few minutes—two or three—the rotation of the earth will become noticeable. The cardboard with its line is actually turning, and its south end is moving towards the east—that is, counter-clockwise.

DR. CHARLES S. HASTINGS of Yale, now retired, tells me that in demonstrating the Foucault pendulum experiment before his classes in physics, he used a bob of cast iron some four inches in diameter, and a piano wire about sixteen feet long. He found that knife-edge suspension was not as efficient in preventing looping as allowing the wire to rest in a V-grooved support at a slight angle (shown at A in one of the draw-



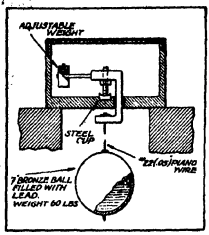
HOW THE EARTH ROTATES

The rotation is counter-clockwise in the northern hemisphere, but goes with the hands of a clock in the southern hemisphere



STARTING THE PENDULUM

It is held back by a string until it comes to rest. The string is then burned. These precautions are essential to success



ANOTHER METHOD

Elevation drawing of the pendulum installed at the National Academy of Sciences

ings). He remarked on the close agreement of the measured rotational rate of the pendulum with theory, usually with less than ten percent of error, even during as short an interval as 15 minutes. He used a hard brass wire which would not carry more than two (perhaps three) times the weight of the bob. This is probably not unimportant.

There remains the mathematical demonstration of the rate of rotation of the pendulum for any given latitude. It is obvious that if the pendulum were to be set swinging at the north pole, the cardboard and the earth would make one complete rotation under it in 24 hours. At the equator, on the other hand, there would be no rotation of the cardboard with respect to the plane in which the pendulum swings.

For positions intermediate between pole and equator let us consider an observer at some northerly latitude, O (see drawing at top of page 12). Here the pendulum is set swinging north and south, OH. After an interval (t) the rotating earth moves the position of the observer to O'H'. But angle H'O'H=angle OHO'. The arc OO' is common to OHO' and O-center of earth-O'. Whence,

$$\frac{\text{OHO}'}{\text{O-center-O}'} = \frac{\text{O-center}}{\text{OH}}.$$

But O-center divided by OH is the sine of the latitude, for the rate of rotation, $\frac{\text{OHO}'}{t} = \frac{\text{O-center-O}'}{t} \times$ sine latitude.

That is, while the earth rotates through angle O-center-O', the pendulum, relative to the earth, rotates through the lesser angle OHO', and therefore its angular velocity is less than that of the earth. Thus, when the earth has made one revolution the pendulum has not done so, and must be swinging in a different direction with regard to the meridian over which it was set vibrating 24 hours earlier. That this must be so seems conclusive from the above demonstration, but it is not so easy to visualize.

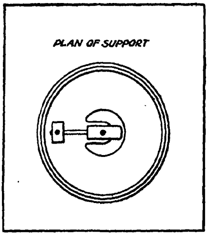
I have followed Hastings' treatment (Hastings and Beach, "General Physics, 1898," page 60), but Jones in his new "General Astronomy," page 13, employs the same steps and arrives at the same results.

Very well, if you want to exercise your imagination, get your terrestrial globe and try to figure out how this state of affairs can be. I spent one evening with several Springfield amateur astronomers, trying to unravel the mystery, but it was given up in despair. Perhaps some reader of the Scientific American will take pity on us and send us the answer.

To return to our demonstration: the angular velocity of the observer O is, of course, 15° an hour. Therefore the rate of rotation of the pendulum, OHO', is 15° per hour × sine of the latitude. For the neighborhood of New York, whose latitude is 41° (sine = .65), the rate at which the pendulum will rotate is therefore 15° × .65 = 10° per hour.

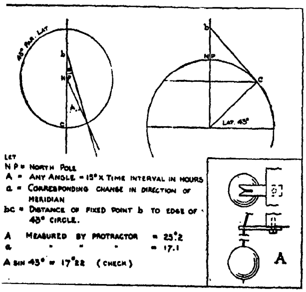
To check this in actual practice, mark off on the cardboard an angle of 15° from the central line and subdivide this angle to single degrees. Then note the number of degrees the card turns from the path of the needle. The cardboard rotates at the rate of 10° per hour—that is, at the rate of one degree per six minutes—and if the amplitude or length of swing of the pendulum is two feet, one degree on the paper amounts to about one-eighth of an inch. So it takes only a few moments to make the rotation of the earth apparent.

I would like to see a Foucault pendulum apparatus of some type in every school and library in this country, for its educational value alone.



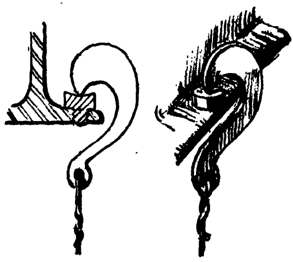
VIEW FROM ABOVE

Plan drawing of the installation shown in elevation in the drawing at the left



GRAPHIC SOLUTION OF THE RATE OF ROTATION

...n latitude was furnished by Dr.



AUTHOR'S METHOD OF SUSPENDING THE PENDULUM

A brass hook one-eighth of an inch in thickness rests in a cup of

OUR POINT OF VIEW

PROPAGANDA

RARELY has a word in our language been misunderstood and misused so widely as the term "propaganda." We have come to the way of thinking that if we apply the word "propaganda" to a movement for the dissemination of an unpopular truth, we have nailed that movement to the cross. So true is this, that "propaganda," in the minds of the uninstructed and unthinking majority, has come to stand for deliberate lying; so that when a man finds himself being worsted in an argument, it is more likely than not that he will throw out a sheltering smoke screen by shouting with gusto, "I and my cause are the victims of propaganda."

Now, "propaganda" is a perfectly good and wholesome word, with an honorable lineage behind it. Only during and since the World War has it been clothed with its present sinister significance. Centuries ago it originated in the missionary activities of the Roman Catholic Church and was applied to a society of cardinals who directed foreign missionary enterprise, and formed the College of the Propaganda for the education of missionary priests—a perfectly laudable enterprise as everybody surely will admit. In this sense, any body of men who are associated for the dissemination of some truth or doctrine may be called "propagandists," and it is only when such united effort seeks to distort the truth, and disseminates what it knows to be hurtful and trouble-making lies, that the term takes on its sinister meaning.

UNADULTERATED NERVE

THAT modern advertising has become a potent force for good, no one of intelligence even wishes to deny. Long past is the day when the owner of a business regarded dubiously—"as good as thrown away"—the 5 percent of his annual earnings which advertising men urged him to "forego this year, that profits might be all the greater next year." Long ago has the phrase, "It pays to advertise," become trite with acceptance; one would find it no more necessary to go about urging that two and two make four, or that the sun rises in the east.

More recently we have seen how great advertising campaigns are conducted. Given the money, it is possible to introduce—"put over"—any worthy new product on an old market; the results are in proportion to the expenditure. But can miracles be accomplished by advertisers? Are we all such dunces that they can ram anything they wish down our throats?

The *Glass Container* is a special organ "published in the interest of all makers and users of glass containers, and the contributing industries." It advocates glass bottles for liquids, glass jars for foods, and, almost, glass everything for everything—which is a pretty good idea. Evidently, however, its editor believes rather fully in the power of advertising to hypnotize the public into the belief that two and two make three, or maybe five. It seems we are all going to stop wanting fresh foods and begin craving canned foods—in glass containers, of course—and actually like it. The following is a quotation from an editorial box conspicuously printed on the front cover of a recent issue of that journal:

"The destiny of the food-packing industry," it says, "lies in the hands of the food packers themselves. If they will not attempt to make the public prefer canned to fresh products, then they will have only themselves to blame if they find themselves with a cadaver on their hands where once rested a thriving industry."

For cool, unadulterated nerve, this has anything we have read in a long time nailed to the mast. Make the public *prefer* canned to fresh products! Readers, is your intelligence and ours about to be operated on by means of "educational" campaigns so that we shall *insist* on the genuine canned foods, accepting no fresh substitutes? Will constant hammering accomplish the change of opinion? Shall we in the end find ourselves becoming indignant when well-meaning grocers try to foist on us fresh foods? Or picture yourself in a restaurant saying, "Waiter! Take away these fresh peas—I ordered canned peas!"

Few advertising men will be found to undertake such a silly campaign.

The Mississippi Lesson

THE unprecedented rainfall which caused the Mississippi flood was an act of God. The bursting of the huge flood through its artificial banks was an act of man. It is chargeable to the shortsightedness, lack of cooperation and petty local rivalries of the lay population and its non-technical representatives in Congress. The only men who understand the Mississippi problem are the United States Army Engineer Corps. Years ago they formulated a plan. Had Congress authorized the full sum needed for its execution and year by year granted the appropriations for the *continuous* execution of the project, it would, today, be completed and the flood would have passed harmlessly to the gulf. The levees, as they stand, are a chain, full of missing links.

THE CITY BEAUTIFUL

WHEN the traveler gets his first sight of Manhattan, he is fascinated by the "marvelous skyline" and justly so; for the picture presented has all the qualities of surprise, majesty and picturesque beauty. But it requires something more than a striking skyline to produce the "City Beautiful." Many of the buildings that contribute to skyline effects, are found, upon closer view, to be oppressively monotonous, devoid of any appeal to the imagination, utterly lacked of any treatment that would give them architectural appeal, or place them in harmony with their surroundings. We are justly proud of the New York Public Library as a dignified and artistic work. Within the past few months, it has been overtopped by a 30-story, brick, office building, across the street, which lifts its vast, yellow, monotonous bulk into the heavens—a blazing, vertical Sahara, unrelieved by those shadow effects which a skillful artist knows how to use with telling results. And in every city there are many such. Our own Art Commission's supervisory powers should be broadened to cover the modern office building.

TUNNEL VENTILATION

RECENT preliminary and partial tests of the ventilating plant for the Hudson River Vehicular Tunnel seem to have worried the officials in charge of the work. On paper, the present plan of forcing air into the tunnel at the roadway level and drawing it out by powerful suction at the ceiling level, strongly commends itself as the most direct way to remove the monoxide gas from the tunnel. On the other hand, should a truck loaded with combustible material catch fire in the tunnel, the upward rush of air from the roadway might well serve as a forced draft to increase the heat and rapidity of the fire.

It seems that preliminary tests with combustible material, purposely set afire in the tunnel, has brought this forced-draft effect to official attention. We do not question, however, the ability of the engineers to meet this problem and solve it satisfactorily. If 10,000 feet of vehicular tunnel cannot be fully and safely ventilated, there remains the moving belt or platform, which could be so designed as satisfactorily to meet the emergency.

The Month in Medical Science

A Review and Commentary on Progress in the Medical and Surgical Field

By MORRIS FISHBEIN, M. D.
Editor of the Journal of the American Medical Association *and of* Hygeia

Stretching the Back

PERSONS with contracted muscles and ligaments in the back and with weak abdominal muscles are frequently told by physicians to take certain exercises that will improve the flexibility and power of the muscles concerned. A simple apparatus described by Dr. Philip Lewin consists of a one and one-half inch belt strap 15 inches long, fastened to the floor, and a small stool, 14 inches high, 11 inches wide and 18 inches long, placed as shown below. This apparatus could readily be made at home.

The subject sits on the stool and the forefeet are slipped through the strap. The hands are placed behind the head. On the count of one, the trunk is allowed to hyperextend until the head touches the floor. It remains in this position during the counts of two and three, and on the count of four the return to the starting position is made.

This exercise should be done from 10 to 20 times each morning and night, but this number is to be attained gradually. At first a pillow or soft pad is placed on the floor to receive the head, so that the extreme position is not assumed. During extension there is a combined effect of gravity resisted by the abdominal muscles. During flexion the abdominal muscles are given much work to perform and are well exercised.

Hair Encircling a Finger at Birth

DR. JAMES J. SNIPES reports to the American Medical Association the case of a child aged four weeks which was found to have a contraction around the center of the first phalanx of the middle finger of the left hand at birth. Because of the contraction, the finger was somewhat swollen and there was a slight ulceration present.

APPEARANCE OF FINGER

It is thought that the hair encircling the finger was present at the time of birth of the child

In cleaning the finger, a hair was found imbedded in the crease and completely encircling the finger. When the hair was removed the finger gradually returned to normal. So far as is known, the encircling hair was present on the finger at birth.

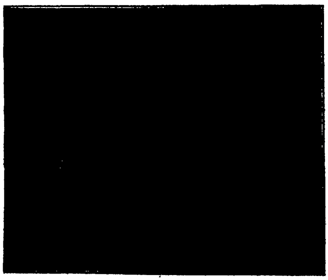
Synthalin in Diabetes

ALTHOUGH the product synthalin for the treatment of diabetes is not yet available in this country and not yet established as actually useful in the treatment of this disease, investigators abroad continue to study it with a view to determining its actual merits. A Hungarian physician, Dr. Hetényi, reported to the Budapest Royal Medical Society the results of its use in 14 cases. In ten, the drug seemed promising because when taken by mouth the patients were freed of sugar and the effect was relatively lasting. However, in four cases its use was accompanied by loss of appetite, disagreeable symptoms related to the stomach and intestines, and nausea and vomiting. In some cases the drug seemed to irritate the kidneys and women who were weak or especially nervous reacted seriously to its administration.

In view of these dangerous side effects, the Hungarian physicians believe that the advantages of synthalin over insulin, because of its cheapness and the fact that it can be taken by mouth, are not sufficient to warrant its use. It is, of course, possible that continued experimentation will develop a product free from such side effects.

FIRST POSITION

The simple apparatus for stretching the muscles and ligaments of the back, as well as those of the abdomen, is shown here in use, the exercise to be performed morning and night



SECOND POSITION

The back is arched and the abdominal muscles are exerted to

A Vitamin to Control Iron in the Body

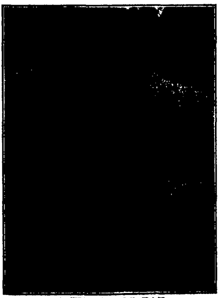
DR. NINA SIMMONDS, Miss J. Ernestine Becker and Dr. E. V. McCollum of the Department of Chemical Hygiene, School of Hygiene and Public Health of Johns Hopkins University, have recently completed investigations which indicate that vitamin E, first described by Evans and Bishop of the University of California as a factor controlling sterility, is also responsible or in some manner associated with the way in which iron is assimilated in the human body. The work done by previous investigators indicated that a deficiency of this vitamin resulted in the death of the fetuses in rats, and it is the belief of the Baltimore investigators that this death is due to a crisis in iron assimilation and that the death may be prevented by giving vitamin E in appropriate amounts from the beginning of pregnancy in the mother rat.

The authors are also inclined to associate the results of their investigations with the encouraging observations made by Minot and Murphy regarding the eating of diets containing large amounts of liver in the treatment of anemia. They point out that liver fats contain vitamin E in considerable amounts, and that the liver also contains much iron.

As a by-product of their investigation, it was found that the iron salt known as ferrous sulfate is not a satisfactory source of iron, but that the ferric citrate will serve the purpose. Wheat germ oil is also an excellent source of vitamin E.

An Unusual Tumor

AMONG the most unusual of the tumors affecting man, particularly in the extraordinary appearance that they may produce, are those composed of fat. They may appear anywhere in the body.



A TUMOR OF FAT

This growth continued for 25 years and was finally removed by a very simple operation in which only local anesthesia was used

AUTOMATIC ELECTRICAL TIMER

This device warns the patient or doctor when the time period for a certain treatment is completed

In a case described by Dr. R. J. White of Fort Worth, Texas, the tumor affected a man 64 years of age. As shown in the picture, the tumor very much resembled a female breast. It began when the man was 24 years of age and grew intermittently until he was 49 years of age, after which it apparently ceased to grow further. The tumor was entirely of fat and did no harm, except by its unusual appearance. It was easily removed with a simple incision of the skin under local anesthesia.

The remarkable fact in the case is that anyone would continue to carry such a deformity when the remo was such a simple matter.

Treatment Timer

SINCE the coming into scientific medicine of modern methods of treatment by the use of light, X ray, continuous warm baths, and similar procedures in which the treatment may extend over varying periods of time, from a few minutes up to several hours, and in which excessive treatment may produce harm, it has been necessary to develop means for automatically controlling the applications. Such a device is the treatment timer described by Dr. H. L. Classen of Ohio.

The device correctly times periods of from one minute up to 45 minutes; warns the operator and automatically turns off the electric current after the end of the time period for which it is set; may be automatically turned off by the patient, and is automatically integrating. It is not necessary to wind it up or to control it in any other fashion than merely to turn on the switch when the device is in use.

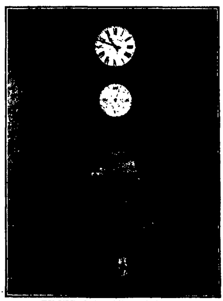
Counting the Fetal Heart Beat

DR. JOSEPH B. DELEE, chief physician of the Lying-In Hospital in Chicago, an institution noted for its contribution to the advancement of this branch to medical science, has been able with the assistance of the firm of Vacheron and Constantin of Geneva, Switzerland, recognized as among the greatest of watch-makers in the world, to develop a watch and a clock for assisting the physician in counting the heart beat under circumstances when it is unusually rapid or heard with difficulty. This is especially important in a case of an infant previous to birth, when the fluctuations, the rapidity, rhythm or character of the heart tones may be of great significance.

Dr. DeLee is authority for the statement that it is possible to diagnose injury to the brain of the unborn child under such circumstances, and even to predict whether it will have convulsions after it is born.

The clock shown in the illustration rings a bell every fifteen seconds. The physician listens to the beat of the baby's heart with a stethoscope that fastens to a headband and which need not be touched by hand. When the bell strikes, the physician counts the beat until the bell strikes again, which is exactly 15 seconds measured time.

A watch, slightly larger than the usual watch, is also made with a bell-ringing attachment. This size is ideal for portable use.



TIMER FOR THE HEART

The clock rings a signal bell every 15 seconds. During the interval, heart beats are counted. It is thus unnecessary to watch the clock

Courtesy the Yerkes Observatory
THE DOME OF ONE OF THE GREAT TELESCOPES AT MT. WILSON OBSERVATORY

Is Mars Habitable?

Its Habitability is Made More Probable By Recent Observations Whether it is Actually Inhabited is Still Unknown

By HENRY NORRIS RUSSELL, Ph. D.,
*Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mt. Wilson Observatory of the Carnegie Institution of Washington*

EVERYONE knows that astronomical observation is a trying business; the picture of the "pale astronomer" working at his telescope the whole night long is a commonplace. But, except in a few isolated fields of research, the astronomer's work has only begun when his observations are made and duly recorded. He must interpret them—and this "discussion" of his observations often takes more time and work than the making of them.

Those who do not understand this are likely to be impatient to learn the results of the astronomer's work. They know that some noteworthy event—an eclipse, a close approach of a planet, or the like—occurred months ago and they ask, "Why don't they tell us what they discovered?" Meanwhile the observers are busy finding out just what the observations have indicated—checking their results in every way they can think of, applying all possible tests, until the sheets of calculations grow into a mighty pile.

A VERY good instance of this is found in last year's study of Mars. Six months have passed since the observers were busiest with their telescopes, and the first detailed account of their conclusions has just been published—a summary of the work of Dr. Coblentz of the Bureau of Standards, in cooperation with Dr. Lampland of the Lowell Observatory. The particular question under discussion is the very interesting one of the temperature of the planet's surface—upon which the observations of 1924 gave the world the first really trustworthy information.

We may recall that these observations are made with the aid of a thermocouple—that most delicate device in which the planet's rays heat up a tiny speck of blackened metal at the junction of two wires of different alloys—and set up a feeble electric current which is recorded by a sensitive galvanometer. By mounting the apparatus in a vacuum, and making it extremely small, great sensitiveness may be secured; one of Dr. Coblentz's thermocouples was only 1/200 of an inch in diameter. Such an apparatus, with proper precautions, measures the heat which comes in from the planet, or rather, from that particular part of its surface whose image fell on the receiving device. (The smallest thermocouple covered only one thirteenth of the diameter of the image of Mars.)

We have no time here to tell the story of the long series of researches which led to the development of the amazingly delicate and efficient devices now in use. Some idea of the care employed, even in handling the instruments, may be gained from Dr. Coblentz's remark that one instrument containing these brittle filaments as fine as hairs is "still in good condition in spite of one trip to California and four to Arizona, totalling over 26,000 miles."

Reliable measurements can now be made as a matter of routine; but how are we to interpret them? Some of the heat from the planet is carried through the ether in short waves—this corresponds simply to the reflected sunlight. The rest comes in long waves, emitted from the planet's warm surface. By the interposition of suitable filters—cells containing water, or plates of glass, quartz, or fluorspar—the waves of different lengths may be sorted out, and their relative heat-carrying powers compared.

WHEN this is done, the quest would be fairly plain sailing if only there were no atmosphere on the earth, and none on Mars; for the relative amounts of radiation of the various wavelengths given out by a standard body at various temperatures can easily be computed, and we would only have to match these with the observed data. But, as things are, the earth's atmosphere interposes an additional screen, imperfectly transparent, and varying hourly in its transmission, as weather conditions change; also as the planet's rays traverse various thicknesses of air as it raises or sinks in the sky.

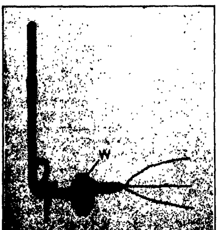
The higher the altitude of the observatory and the drier the air, the less will be these difficulties; so that Flagstaff was, in these particulars, an exceptionally good observing station.

After allowance has been made as fully as possible for our atmosphere,

there remains the difficult question of the effects of the atmosphere of Mars. We are sure that the planet has an atmosphere, although probably one much less dense than the earth's. There can no longer be any doubt that the polar caps are really composed of snow; and the presence of water vapor in the Martian atmosphere, after these snows have for the most part disappeared, has been shown by direct spectroscopic tests. Clouds, although far less abundant than on earth, have also often been observed on Mars.

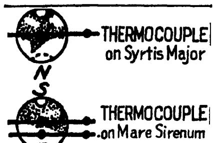
What effects will all these things have on the observed radiation and the deduced temperature? Clouds and even a thin haze reflect a good deal of sunlight back into space, thus depriving the planet's surface of some of its income of heat. This influence, by itself, would make the surface cooler. But the heat which does get through the haze to the planet's surface has to get out again; and a damp atmosphere, even if not visibly cloudy, is very effective in blocking the outward passage of most of the long waves. This second influence acts as a heat-trap, and tends to warm the surface. Under certain conditions, it may considerably exceed the first in importance, and a planet with a moist, slightly hazy atmosphere may be a good deal hotter on the surface than one without such a protection. It is almost certain, indeed, that this influence is a major factor in making the temperate zones of the earth habitable. Without it New York might be as cold as Greenland is now.

DENSE clouds would produce a more nearly balanced effect, by day; but if they formed at night, they would act as a very effective blanket against the escape of heat from the surface and might do a great deal to raise the average temperature for the whole 24 hours.



The radiation enters by window W. The observer's window, for sighting the couple, is at C. Between them the thin thermocouple shows faintly

When, however, we consider what influence clouds or water-vapor haze will have on the observed heat radiation from a planet, we have quite another story. The short waves of sunlight are reflected back to us in larger amounts than before, while the long waves coming from the underlying surface are partly prevented from getting out. These two effects work the same way, and should cause the observed proportion of long-wave to short-wave radiation to be much di-



THERMOCOUPLE ON MARS

The tiny junctions are about the size of a period. They can be placed over any chosen part of the planet's image

minished. For an atmosphereless surface, this would correspond to a lower temperature; hence the temperature of a cloudy or hazy part of the Martian disk, as calculated by the (relatively) simple formulae which have usually been employed, will be lower, and may be a good deal lower, than that of the actual surface beneath.

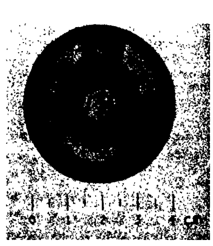
Dr. Coblentz uses this principle to explain one of the worst puzzles of the observations of 1924. The region of the polar caps, when the snows are rapidly diminishing, when tested by radiation measurements, appeared to have a temperature of —60° Centigrade, or about 75° below zero, Fahrenheit. Now it may perhaps be that the snows evaporate into dry air at a temperature a little below the freezing point, but at anything like this degree of cold they would show no tendency to evaporate at all. The actual surface temperature at the edge of the caps is, at the worst, probably about zero, Fahrenheit, and may be a good deal higher.

Similar considerations apply to the measurements upon the eastern and western limbs of the planet (when the sun is just rising or setting) which appeared to be pretty cold, with temperatures of 20°, Fahrenheit or lower. Here one line of sight penetrates the Martian atmosphere obliquely, and any effect of haze would be heightened.

Taking all these things into account, Dr. Coblentz arrives at the following estimates of the actual surface temperatures of different portions of the planet. In the south polar region —in the latter part of its summer season — the temperature probably ranges from 15° to 50°, Fahrenheit; in the south temperate zone (summer), 65° to 75°; in the tropics, at noon, 65° to 85°; in the north temperate zone (winter in rather low latitude), 30° to 60°; nearer the north pole, where the winter days are short, from 10° to 40° below zero. All these are temperatures at *noon*; at sunrise the temperature is probably not much above zero, and at sunset, perhaps 15° or 20°, Fahrenheit. The nights, even on the equator, are probably very cold, and at the sunless pole the temperature may fall very low.

ALL these results differ widely from the opinions which were held, even by the best authorities, five years ago; but they rest upon a solid foundation of measurement, and afford a sufficient base for change of the prevailing expert opinion. They are not without independent confirmation. Pettit and Nicholson, at Mount Wilson, have made similar observations. Their results for 1926 are not yet announced; those of 1924 indicated a temperature at noon in the tropics of about 80°, Fahrenheit. Coblentz emphasizes the point that the results obtained at the two observatories are *not* in disagreement, (as has erroneously been supposed by some uncritical readers). The numerical differences in the published statements depend on the fact that the corrections for the probable effects of clouds and haze have been applied in some cases and not in others.

Just how great these corrections may actually be, future research must tell; Dr. Coblentz states expressly that his values are subject to further revision. But there can now be little doubt that, owing to atmospheric influences, the surface of Mars is a good deal warmer than even once supposed, and there appears to be no further difficulty on the score in regarding the planet as habitable.



WHAT THE OBSERVER SEES

Here the reader is looking through window C of the figure on opposite side of the page. The two round thermojunctions show quite plainly here

Courtesy of Peabody Museum, Harvard University

EXCAVATORS AT WORK IN A TYPICAL REFUGE CAVE OF CLIFF DWELLERS

American Farmers of 4000 B.C.

A Brief Survey of the Known History of Our Southwestern Aborigines

al Research Council

THE tremendous public interest aroused by the discovery of King Tutankhamen's tomb, and by the opening, one by one, of its treasure-packed chambers, served to put archaeology, so to speak, "on the map." Since then archaeological news from various parts of the world has been regularly on the front page of our great dailies, and the periodical press has carried an increasingly large number of special archaeological articles. As a rule, however, the press notices and the feature stories have described work done at single sites, or have recorded isolated finds of spectacular specimens; the public has had only the highlights.

If mere incidents in the great drama of man's rise from savagery can command public attention, much deeper and more intelligent interest will be aroused when the entire story can be told. The major part of that story is still to be unravelled, for even the best informed students of the human past can as yet catch only fleeting glimpses. But in some regions, because of abundant remains or fortunate accidents of preservation, the outlines, at least, of pre-history are shaping themselves. One of these regions is the American Southwest.

The Southwest, archaeologically speaking, comprises those parts of Colorado, Utah, Nevada, Arizona, New Mexico, and the Old Mexican State of Chihuahua which contain remains of the Pueblo Indians or of their cultural ancestors. The region is in general a semi-arid or arid plateau, much of it is true desert, and it is, one would naturally suppose, the very last place in which primitive man could have made unassisted any advance from barbarism. Yet here there grew up the highest civilization that was achieved by any Indian people in the United States, and that civilization was intrinsically so strong, and was so well adapted to its peculiar environment that, of all the native cultures of our country, it alone has survived to the present day in anything like its aboriginal purity. And, as I said above, we are now able to trace its history with considerable accuracy.

Long before the birth of Christ, probably two or three thousand years before, the mesas and canyons of the Southwest were roamed over by little groups of nomadic Indians. They led a hand-to-mouth existence by hunting such small game as existed in that barren land and by gathering scanty harvests of wild seeds and roots. In some way, not as yet clearly understood, there reached these people seeds

Bringing Order Out of Chaos

Has it been the experience of the reader, as it is that of the Editor, that a great deal has been written about the archaeology of the Southwestern States, without greatly clarifying the subject as a whole? Usually the writer, being himself an expert on his own subject, assumes that the reader already knows the fundamentals of it. And the reader usually does not.

With this in mind Professor Kidder, an authority on the archaeology of the Southwest and author of a notable recent work entitled "Southwestern Archaeology," was asked to prepare a short survey of the subject. This he has admirably done, and the reader will now have a peg on which to hang future statements about the archaeology of the Southwest.

The main periods are *approximately* as follows: Pre-Basket Maker, ? to *2000* B.C.; Basket Maker, *2000* B.C. to *500* B.C.; Post-Basket Maker, *500* B.C. to *1* A.D.; Pre-Pueblo, *1* A.D. to *250* A.D.; Early Pueblo, *250* A.D. to *500* A.D.; Great Pueblo period, *500* A.D. to *1100* A.D.; Period of decline, *1100* A.D. to *1540* A.D.; European Discovery, *1540* A.D.; Historic Period, *1540* to *1927* A.D.

of corn, the great native American cereal, which had still earlier been brought under cultivation in Mexico. They began to plant corn in favorable places, and the possession of fields that required attention, together with crops they could depend upon, gradually served to wean them from their wandering habits.

It is at this stage, this dawn of farming in our country, that we get our earliest real knowledge of life in the Southwest, knowledge painstakingly recovered by many archaeologists excavating in dusty burial caves. We see a strongly built folk, long-headed, tallish, living in little communities scattered among the gorges of northern Arizona and southern Utah. We call them the Basket Makers, because not yet having learned to mold pottery vessels, they placed with their dead offerings of beautifully woven baskets.

Courtesy of Peabody Museum, Harvard University

CLIFF HOUSES IN ARIZONA

This is part of the Betatakin ruin in northern Arizona. Another part is shown in the illustration below. Study the masonry from a structural standpoint

THE Basket Makers, according to S. J. Guernsey of Harvard, the leading authority on this period, apparently lived in perishable brush huts, all trace of which has now disappeared. They took advantage of the great caves, which occur so commonly in the canyons of the Colorado River drainage, as storage places for their crops. Holes dug in the sandy floors of the caverns, lined with stone slabs, and roofed with poles and brush, served as receptacles for harvested corn, and very often these same holes were used as burial places. When, as was often the case, the cave was protected from rain by an overhanging roof, the sandy deposits within were kept bone-dry and quickly absorbed all moisture from the interred bodies, dessicating them to mummies as perfect as those of Egypt. Nor did decay overtake the wrappings and the offerings of baskets, textiles and weapons that had piously been placed with the dead. They come from the graves as fresh and as sound as the day they were made, a thousand years or more before the birth of Christ.

Good fabrics the early Basket Makers wove, all by hand, for the loom had not yet been invented. They did not even have the bow-and-arrow, but used instead a long, light, flint-tipped dart, hurled with the aid of a peculiar wooden spear-thrower. These lances were no mean weapons, however, for in the Natural History Museum in New York there is a Basket Maker skull with a dart-point driven deep into the bone.

We know that the Basket Makers were the first agriculturists of the Southwest, because wherever we find their remains in the same cave with the relics of other people, the latter always lie above them. This simple principle of stratigraphy, which geologists and palaeontologists have utilized to reconstruct the history of the earth and the succession of extinct types of animals, has also been of the greatest value to archaeology, particularly in such regions as Arizona, where many successive peoples lived in the same places. Among other things, it enables us to recognize the later stages of the Basket Maker culture.

This later period, which is called the "post-Basket Maker," brought with it no change of race. The mummies and the skeletons are all of the same long-headed people. But they had made two most important discoveries: that clay could be molded into vessels and made hard and watertight by burning; and that flat stones piled one upon another would make a wall. These beginnings of architecture and of the pottery art were not carried far by the post-Basket Makers. They were long satisfied with crude vessels, and during the centuries of their occupancy of the region they hardly erected a house worthy of the name. But the discoveries had been made, and it needed only the energy of a new people to carry them forward.

Courtesy of Peabody Museum, Harvard University

BETATAKIN CLIFF HOUSE

The straight, nearly vertical black line above the center is an ancient pole used by the former occupants. By shinning up it one can reach a spring on a ledge

Certainly not much later than the year 1, quite likely earlier—the dates of these remote periods are still very uncertain—the new people arrived. They were a round-headed folk, shorter of stature and lighter of bone than the Basket Makers and their descendants the post-Basket Makers.

IT is hard, in the present fragmentary state of our knowledge, to make even an intelligent guess as to where they came from, but in view of the fact that deserts, mountain ranges and great canyons make formidable barriers to the north, northwest and west, it seems likely that they filtered in from the south or the east. Of these two directions the south seems perhaps the more likely, as the agricultural nations of central Mexico may well, about this time, have been expanding to such an extent as to set up an outward pressure, thus causing northward movements of population.

At all events, the new people arrived in the post-Basket Maker country, and eventually replaced the old long-headed type. I referred above to this immigration as a filtering, and such it seems to have been, for there are no signs of a sudden destruction of the post-Basket Makers. Furthermore the newcomers took over the old way of life practically as it was, and this they could hardly have done had they swept over the country as a Hun-like horde. Earl H. Morris has, indeed, found evidence that the two races lived for a short time mixed together in the little canyon communities.

The new people we call the "pre-Pueblos." They were without doubt the direct ancestors of the Pueblo cliff-dwellers of the later prehistoric periods and, in turn, of the Hopis, Zunis and other present-day Pueblos. They took over the culture of their predecessors practically unchanged. They built the same sort of crude houses, and made only slightly

better pottery. But they eventually began to group together in larger settlements, to improve their dwellings by raising higher walls of masonry, to fashion better and decorate more elaborately their earthen vessels. Cotton also seems to have appeared at about this time, and the bow began to be used.

PROGRESS was slow and it probably took some hundreds of years to develop the compact house-cluster of solidly built rectangular rooms that is usually considered to mark the opening of the Pueblo period. The early part of this period is remarkable for the rapid extension of agricultural communities in the Southwest. The post-Basket Makers and the pre-Pueblos seem to have had a somewhat restricted range in northeastern Arizona, northwestern New Mexico and nearby regions in southern Utah and Colorado. The early Pueblos, however, spread out far and wide from this center and the remains of their villages are found over a vast extent of territory. Conditions were evidently most favorable for them, the climate was perhaps slightly more moist than it is today, and it is certain that they were in little, if any, danger from human enemies. This is proved by the fact that their towns were small, were widely scattered and were not built with any reference to ease of defense.

These good times, which apparently lasted until the sixth or seventh centuries of our era, were brought to a close by the arrival in the Southwest of nomadic foes. Again, we do not know who they were, but their onslaught was evidently ferocious, for they very quickly caused the abandonment of practically all the outlying regions, and forced the Pueblos to gather together in the central and southern parts of their old range.

Courtesy of the Peabody Museum, Harvard University

BASKET MAKER MUMMY

The wrappings consist of brightly colored textiles

There now opened the Great Period of Southwestern history. The Pueblos had been obliged to congregate in a more or less limited area. Large towns gathered to themselves the inhabitants of the little scattered villagers of former times. Community of interest stimulated community of effort. The necessity for protection against attack led to the selection of easily defensible house sites or, if such were not available, the building of compact, fortified structures sheltering hundreds of families. This was the era of the cliff-houses, those dizzily placed dwellings in caves and on high ledges, that have aroused so much interest and speculation.

To the Great Period belong Cliff Palace and Sprucetree House in the Mesa Verde National Park; Betatakin in the Navajo National Monument; and the many cliff-houses of Canyon de Chelly. During the Great Period also were built Pueblo Bonito and the other huge village of Chaco Canyon, now being excavated by Neil M. Judd for the National Geographic Society. It was a time of great achievement, both in architecture and in all the other arts; pottery-making flourished, weaving was brought to great perfection and it is probable that there were developed some of the elaborate ceremonies such as the Snake Dance, which are still carried on by the Pueblos of today.

WHAT caused the abandonment of the prosperous communities of the Great Period is still uncertain; possibly drought, possibly further attacks by strengthened foes, possibly inbreeding due to isolation of units of population. All we know now is that they were abandoned, most of them, presumably, about 1100 A. D. No cliff-house, nor any one of the great northern pueblos was occupied when the Spanish arrived in the Southwest in 1540. Between these two dates the Pueblo Indians were forced or migrated into the territory along the Rio Grande and in the Little Colorado drainage, where they live today.

This is a very brief outline of the history of the Southwest. Nor can we today write with confidence anything more than an outline. But further excavation will fill in the details, further study of the ruins, of the pottery, and of the skeletons will tell us much that we do not yet know as to the cultural and racial relationships of these most interesting peoples of the American Southwest.

Courtesy of the American Indian-Heye Foundation

ROUND DWELLINGS IN A BASKET MAKER CAVE

Courtesy of Phillips Andover Academy

PUEBLO SKELETON AND MORTUARY OFFERING

The offering consists of a baked clay pot which may b at the right, near the skull

THE DESERT SANATORIUM AT TUCSON, ARIZONA

The curved dome of the radiometer for measuring daily variations in the intensity

Sunburn in the Dark

Treatment With Isolated Ultra-Violet Rays from the Sun

f Washington

MOST solids and liquids as well as our skins are warmed by the sun's rays. But the fact that the most pronounced cases of sunburn of our faces and hands do not occur on the hottest days or in the regions having the warmest climate, suggests that it is neither visible light nor the so-called "heat rays" beyond the visible red rays in the spectrum of sunlight that causes pigmentation and tanning of the skin. And such a suspicion would be well-founded, for sunburn or similar effects may actually be experienced in radiation which does not give much illumination.

RADIANT energy from the sun exercises highly specific effects according to its wavelengths. For example, when sunlight, which has passed through a solution of green coloring matter (chlorophyll) from the leaves of plants, is spread out to make the rainbow play of primary colors, dark gaps or bands will appear mainly in the region of the blue-violet and red in which the rays have been stopped by the chlorophyll. The energy in that part of the light which is absorbed by the plant is converted into power by which the leaf-mills manufacture sugar and other substances which enter into living matter. This process is absolutely fundamental to life in all of its forms.

Many fads and fancies as to the use of various parts of the spectrum have had wide vogue at various times; yet none greater than the "blue-glass" craze of the 'seventies. Windows with panes of this glass, which, in fact, allowed daylight of low intensity chiefly in the blue-violet to pass into rooms, were installed in the belief that it would have curative and tonic effects on persons or plants living in this magical twilight.

The color of the glass or screen is not an index of the rays which may pass through it. Thus one of the best media for transmitting the ultra-violet rays and shutting out the remainder of the spectrum is a glass as brownish-black as this ink, while another glass which cuts out heat rays, including some of the red rays of visible light, has a distinct greenish tinge.

THE ULTRA-VIOLET RADIOMETER

FIGURE 1—*In the box are the lenses and thermocouple. Above it is the driving motor; below it, the electrically operated escapement. The cable carries to the galvanometer in the laboratory below the minute currents generated in the thermocouple by ultra-violet rays sent out by the sun*

The eye is sensitive to wavelengths only as short as one sixty-five-thousandths of an inch, but it is to some of the rays of shorter wavelength which we can *not* see that attention is now being increasingly paid, as it is found that waves of not more than one seventy-five-thousandths of an inch in length exercise a curative effect for rickets, speed up the vitamines in fatty substances and tan the skin. These are the ultra-violet rays—or, more properly speaking, a part of them, for they do not have the same effect throughout their entire range of wavelengths.

NOW it is a matter of no little interest that these shorter wavelengths from the sun which just pass the screen of air surrounding the earth, and which can not be seen, are of very great importance to animals, especially man. These rays get down to the earth's surface only when the sun is not too far from the zenith or the air too hazy. Total deprivation of the effects of these rays may result in serious ailments, while proper exposures may have curative effects or promote growth, development or tone in

an organism, such as the human body.

Experimental analysis of the extent and character of the effects of these shorter wavelengths is now being carried on vigorously in half a hundred laboratories, and every month witnesses the appearance of contributions dealing with detailed or general effects of the ultra-violet rays on babies, rats, plants, protoplasm, food-substances or vitamines. It is not easy, therefore, to make a general statement which may hold in all features, even over the two months which must elapse before this article is to be published.

It may be safely ventured, however, that, beginning with the shortest waves which reach the earth from the sun, with a wavelength of 290 millimicrons, and ranging up to 320 millimicrons, the effect is to produce greater vigor, accelerate growth and heighten the action of certain vitamines. (A millimicron equals one millionth of a millimeter, or about one 250,000,000th of an inch. The wavelengths of several parts of the spectrum, expressed in millimicrons, are shown in Figure 5.)

THE results of some studies on the effects of short wavelengths on seeds, by Sheard and Higgins, made in the laboratory for experimental medicine of the Mayo Foundation, may be cited as illustrative of the use of mercury vapor-lamps as a source of rays. Rays from 320 to 390 millimicrons in length appeared to favor germination and growth, while rays from 270 to 320 retarded the processes. Both series of exposures were for periods of a few minutes.

As the physician who practices heliotherapy well knows, it is desirable to shield the patient from the more intense heating rays, and care must be exercised not to expose him to the rays beyond a certain time. This duration of time is determined chiefly by the intensity of the ultra-violet light, for these unseen rays in sunlight may by long-continued action exercise a destructive action on the fragile jellies of protoplasm in our bodies. In this very action, in fact, lies the sterilizing effect of sunlight in destroying bacteria and other minute unprotected organisms.

QUARTZ mercury-vapor lamps emit rays which are especially intense in regions of the far ultra-violet spectrum (Figure 5) between 200 and 280 millimicrons, and some of these rays exercise an especially rapid action on living matter and are consequently very efficacious in sterilization. In exposing the human skin to rays from lamps which emit ultra-violet rays the problem is to avoid the disintegrating effects of these shorter, sterilizing wavelengths. This is attempted by various screening devices.

The action of ultra-violet on the constituents of fatty substances which are used in curing rickets is very notable. The vitaminic action is speeded up or accelerated by exposure to rays from quartz mercury-vapor lamps. Recently Dr. Hess and his colleagues have shown that this effect is due to changes in a component of the cholesterol included in cod-liver oil, under the action of rays from such a lamp. However, little progress has been made in the determination of the direct physical effects of ultra-violet rays on the surface of the human body. Our blood carries cholesterol through the tiny capillaries near the surface of the body, but nothing whatever may yet be said as to any direct action of the sun's rays on this substance in our bodies.

Progress in this field has been delayed by the complexity of the problem, lack of adequate technique and by the fact that practical methods of rapid, dependable measurements of the intensity of the ultra-violet component of the sun's rays have until recently not been possible to make.

As will be described below, records of the total intensity of the sun's rays, however accurately made, do not serve as an index of the ultra-violet in them, because fine dust in the air may screen out the short wavelengths; also because the relative intensity of these rays as emitted by the sun varies greatly from year to year. So much is this so, in fact, that a patient exposed to sunlight between 10 and 11 A.M., for example, in May, 1924, actually received less than two thirds the total exposure that he might have received in the same place and position in May, 1927.

DOBSON, of Oxford University, England, found that variations in the energy of the blue-violet sunlight transmitted through a silver film were found to show differences as great as 30 percent from day to day. This method was taken up by Pettit at the Solar Observatory at Pasadena. After some experimentation he designed an ultra-violet radiometer in which a daily record of the intensity of these short waves is traced on a photographic plate, in parallel with a tracing of the intensity of the green light of the sun at the same time.

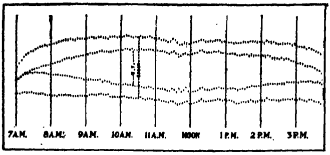
As an instance of the short time in which the instruments and methods of so-called "pure research" may be put to direct use, this ultra-violet radiometer serves as a good example. Dr. Pettit began his studies in June, 1924; before the close of 1925 an in-

HOW THE VARIATIONS ARE MEASURED

FIGURE 2—The contact clock (right), and the lamp (center) from which a beam of light falls on the galvanometer mirror and is reflected back to a screen and measuring scale on left

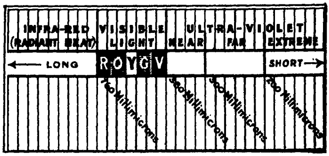
DR. EDISON PETTIT AND HIS RADIOMETER

FIGURE 3—Dr. Pettit is a member of the staff of the Mt. Wilson Observatory. With his radiometer he has shown that the sun's ultra-violet radiation varies widely from day to day



A DAY'S ULTRA-VIOLET RECORD

FIGURE 4—*This sample record covers the day of October 19, 1926. It shows respectively the amount of ultra-violet (inner two rows of dots) and green (outer rows of dots) radiation from the sun on that day. Each four minutes a dot is automatically made by the radiometer. In this particular record local apparent time at Tucson, Arizona, is indicated*



SIGNIFICANCE OF THE TERM "MILLIMICRON"

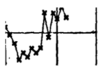
FIGURE 5—*The diagram is practically self explanatory. The letters in the center represent red, orange, yellow, and so on. Through familiarity, the physicist comes to associate various wavelength designations in millimicrons, or sometimes in Angstroms (tenths of a millimicron), with certain parts of the spectrum, a thing the tyro quickly picks up*

crease of 57 percent in the intensity of the ultra-violet had been measured. Some description of these results and of the radiometer by which they were measured was given verbally to the writer in December, 1925. A request for the construction of such an apparatus for the use of the newly founded Desert Sanatorium at Tucson was made in the same month. Construction was begun in February, contemporaneously with Dr. Pettit's publication of results, and a radiometer was installed a year later, as shown in Figure 1. In other words, the second model of a technical instrument for pure-science research in solar physics is already devoted to "applied" science. Naturally this second instrument possesses a perfection of design not in the original.

THE essential part of the ultra-violet radiometer consists of two quartz lenses and a small delicate thermocouple. The lenses are of one inch aperture, with a focal length of 0 inches, and are set in an air-tight cell behind thin quartz plates. Quartz is used instead of glass because it is transparent to the ultra-violet rays of the sun. The inner surface of the quartz plate and lens in one of the cells is covered by two dense coats of metallic silver of such thickness that all radiation except the ultra-violet, that is, radiant heat and visible light, is stopped; while the ultra-violet passes on through the quartz lens and is brought to a focus as a disk of ultra-violet light one fiftieth of an inch in diameter, on a thermocouple. The galvanometer connected with the thermocouple is deflected, and the deflection is recorded photographically on a glass plate. This gives a measure of the intensity of the ultra-violet light.

A second cell, mounted on the same disk as the first, contains a glass plate and a lens coated with gold. This metal, reversing the action of silver, does not allow the ultra-violet rays to pass, but it does transmit most of the visible rays.

The disk with the two cells is now rotated so that the thermocouple is acted on by ultra-violet rays for one minute, then by green rays for the next minute. By this method two lines of dots are made on the record. These show the relative intensity of the green and ultra-violet. Variations in intensity by four-minute intervals throughout the day in both the green and ultra-violet are thus made available. If the thermocouple is exposed to a standard lamp at intervals, the relative values of the green and ultra-violet may be reduced to absolute values. (Figure 4.)



HOW THE ULTRA-VIOLET VARIES

FIGURE 6—*March of the monthly mean value of the ultra-violet solar radiation in wavelength of 32 millimicrons during three years as measured on Mt. Wilson. A maximum was reached in the month of November, 1925*

The radiometer must be kept in continuous adjustment with the sun's apparent movement, and this is done by carrying it on an equatorial mounting such as might serve for a six-inch telescope, as shown in Figure 1.

That it may be advantageous to expose materials, living things and particularly human patients, to some types of radiation and not to others is now abundantly evident. In some operations the red, or heat rays, give the desired effects. At present, attention is being directed chiefly to exposures to the ultra-violet, without undue heating; that is, to the production of effects like sunburn in the dark.

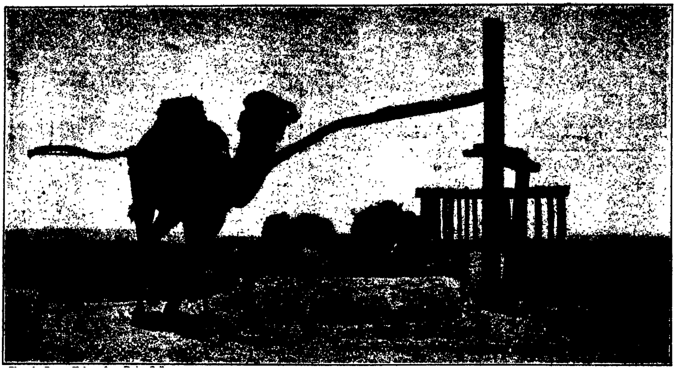
Recognition and public interest in these facts has progressed far, and a well-known news service is authority for the statement that the *London Times* and other newspapers print a daily record of the intensity of the ultra-violet rays received on the city streets. It is now possible to purchase a pocket spectroscope with which the arrival of the ultra-violet rays in the morning may be detected, and their presence confirmed during the day.

Light-screens of various kinds are now available. Sheets of quartz allow all sunlight that reaches the earth's surface to pass into a room. But if a film of silver is laid on the quartz, visible light is stopped, although the ultra-violet is transmitted with near perfectness. A screen of this kind would be an ideal arrangement for the use of a physician for giving his patients ultra-violet treatment in heliotherapy, at the same time avoiding the heating rays. But its financial "temperature" would be high!

TODAY the development of formulae for making glass which will transmit ultra-violet with the least loss is the object of researche than one industrial organization. Some technical success has been achieved, one glass and other media are already in use in a New York hospital and in the Desert Sanatorium. Most of these substances also transmit some of the longer visible rays, which is not always a disadvantage.

Behind the dark-colored glass mentioned, and also behind a sheet of silvered quartz a sunburn in the dark or in an illumination no stronger than that of deep twilight may be possible. Crowded populations living or working indoors are deprived of sunlight and we are becoming aware that deficiencies result from it.

In getting back to natural daylight, some progress has been made in the study of differential effects of various wavelengths. Of these, the shortest which penetrate the atmosphere, and which are beyond the range of the eye, and certain other parts of the ultra-violet, are of very great importance for their curative effects and tonic influence.



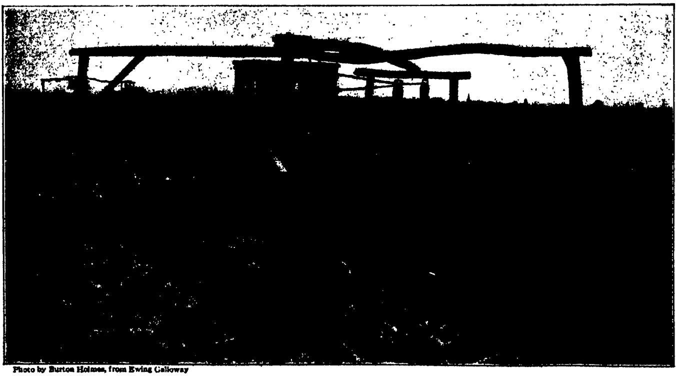


Photo by Burton Holmes, from Ewing Galloway

THE COMMON WHEEL, OR CAPSTAN, FOR IRRIGATION IN HUNGARY

Here there are two buckets and the horse reverses direction after each bucket of water has been raised. The empty descending bucket helps counterbalance the r is not so crude as it seems; its mechanical los

Primitive Irrigation Methods Still Compete With Modern Machinery

Because man-power in many countries may still be had so cheaply, ancient irrigation machinery still squeaks and creaks its inefficient way through a modern world. Some of the irrigation pumps shown on these pages are literally "as old as Moses." Just as civilization stands squarely on agriculture for its existence, so did agriculture itself first depend on the discovery of irrigation.

"The discovery of the device of irrigation and the realization of its tremendous significance involved vastly greater issues than even the invention of so fundamentally important a practice as agriculture," says Prof. G. Elliot Smith in "The Ancient Egyptians." Irrigation, according to Prof. Smith, was first hit on in Egypt. Today, in that arid land the traveler may see in every

Photo by Burton Holmes, from Ewing Galloway

IRRIGATION IN SIAM, WITH THE SIMPLE DRAINAGE WHEEL PUMP

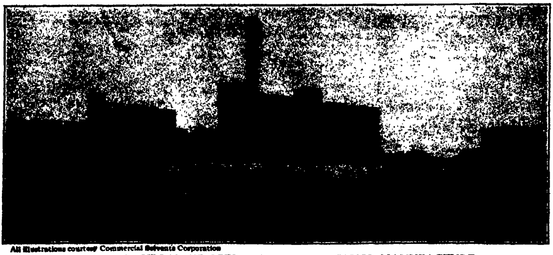
(in this case a woman: the man is busy seeing it right!) keeps the paddles turning by walking
on a set of foot treadles. Thirty-foot wheels of t steam driven, have proved efficient in Louisiana, for

Photo by Ewing Galloway

WALKING WATER UPHILL WITH THE PICOTAH—INDIA

ep. Instead of unterweight, as

field, irrigation pumps that are practically identical with those depicted on ancient engravings. In addition to the "chain of pots" illustrated on page 26, the *shadouf* is widely used in Egypt. The *shadouf* is simply the old-fashioned, counterbalanced well sweep: the workman pulls down on an upright pole, raising the counterweight. In descending, this raises the bucket. This equipment is remarkably efficient if time and labor are no object. Recently Dr. J. S. Haldane and Dr. Yandell Henderson published an analysis of the work performed by one workman irrigating with this form of apparatus. They found that a man in lifting a 60-pound bucket of water 6½ times a minute, did 4,290 foot-pounds of work per minute. From physiological data they reckon the efficiency of the entire unit—*shadouf* and workman—at about twenty percent. This is far above the mechanical efficiency of a boiler, engine and low-lift centrifugal pump such as would be used in a modern installation. Such comparisons are not, however, fair to machinery: it does some things a man cannot do.



All illustrations courtesy Commercial Solvents Corporation

HUGE PLANTS HAVE BEEN BUILT FOR BUTANOL MANUFACTURE

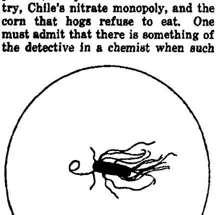
Growing demands for the solvents produced through the activities of a minute microbe form the basis of a flourishing industry. This is one of the Peoria, Illinois, plants that is so engaged

A Microbe in International Affairs

As a Detective, the Chemist Has Unearthed Processes of Vital Industrial Importance

SHERLOCK HOLMES gained his reputation by using unnoticed trifles to build up a chain of evidence to manacle a wrongdoer. Indeed the whole system of criminal investigation is built upon the connections between trifling clues which only a trained eye could find and only a trained mind build into a complete story. Yet one need not go beyond the ordinary bounds of work-a-day business to find thrillers quite as picturesque and details quite as important as could be found in any detective romances. As Dr. Watson might have said to Sherlock Holmes, had he been interested, "That butanol case stirs my imagination. One might believe that so long a chain of circumstances had been entirely invented by a mere writer of fiction and had never existed in real life. Your deductions in that case, my dear Holmes, were perfectly marvelous."

Of course, Dr. Watson never said anything of the kind because the butanol business is a thriving reality and is not in any way to be connected with criminals. Yet the train of circumstances which led to the building of this industry and the many effects it has had in the world of business are far more like a romance than a serious history. As long ago as 1910 the threads of evidence began and ultimately they connected the British War Office, an odd micro-organism, a potential swimming pool, an early unsuccessful effort to make rubber, the demise of the legitimate American whisky industry, the making of charcoal, a new modification of smokeless powder, the paint and varnish industry, Chile's nitrate monopoly, and the corn that hogs refuse to eat. One must admit that there is something of the detective in a chemist when such



THE MICROBE ITSELF

The clostridium acetobutylicum (Weizmann), shown at 240 diameters, converts starch to solvents

apparently unconnected things can be worked together into the foundation of two great American industries.

To bring these apparently isolated circumstances into their proper mutual relations, it is necessary to go back to 1910, and before, when energetic efforts were being made to produce rubber without having to go to a tropical tree for it. A number of chemists working on this problem found that they could produce a kind of rubber by using certain very rare and costly chemical substances. These materials, isoprene and butadiene, could be made without great difficulty from butanol, a very near relative of grain alcohol but not nearly so easy to get.

The search for synthetic rubber was almost at the point of being abandoned when a tiny micro-organism, with a name, as usual, much more imposing than itself, turned up with every apparent intention of saving the day. The day has not yet been saved for synthetic rubber but the *clostridium acetobutylicum* (Weizmann) today is permitted to exercise its remarkable appetite for starch and its still more remarkable ability to convert it into acetone and butanol on a huge scale. Because this butanol was at that time interesting as a raw material for synthetic rubber, the habits and desires of this microbe were studied with minute care and ways were found to make it even more comfortable than a "bug in a rug" or a "contented cow." All of which having been duly determined was recorded with greatest care against future need.

The second circumstantial thread begins with a peculiar specification of the British War Office, that smokeless powder for the British armies be made with acetone as a component of the solvent used in its preparation. At the time that this specification was

LEFT

starch solutions until active bacteria are obtained.
growing under care-
f
a
5

RIGHT

Growth of the bacteria is carefully followed through six days on successively larger scales until the final brew from these thousand-gallon kettles is of proved purity, capable of satisfactory performance in the large-scale fermenters which follow

adopted, no such demand for powder as that of the World War was within the possibility of imagining, and the manufacture of charcoal from hard wood gave every promise of supplying any ordinary need for acetone. Of course, the war changed everyone's conceptions and the British Tommies were shooting away powder at so prodigious a rate that the forests of the world, and particularly those of Britain, might have ceased to exist had it been necessary to depend upon them alone to supply acetone. In this emergency, the British War Office was forced to turn to the microbe of the rubber makers to keep up the essential supply of acetone for its powder factories.

Perhaps no microbe ever enjoyed so essential a part in a war as this one did and every possible effort that time would permit was made to make its working conditions the most satisfactory that could be devised. In England, in India and in Canada, it undertook the task of converting huge quantities of potatoes, rice and corn into the much needed acetone. Neither the War Office nor anyone else was at that time interested in the fact that more butanol was made in the process than acetone, for everyone was too busy doing his part in winning the war, or at least in preparing to tell the world how essential he had been, to worry about the not very pressing problem of rubber synthesis. Later, after our entrance into the conflict, an erstwhile whisky distillery in the Indiana corn belt was converted into a plant for the manufacture of acetone under the joint control of the American and British governments. With this converted distillery, the story might properly begin, for it has served as the foundation on which a new American industry has been built.

THE whisky industry in the United States had always centered around the sources of corn in Indiana and Illinois and had performed the task of converting edible and waste corn, which could not be used for anything else, into a marketable product. When the food administration curtailed the use of corn for this purpose, it was necessary not only to find something to do with the distillery itself but also to find a way to use up mouldy, waste corn. Under these circumstances our microbe was put actively to work producing in this old distillery great quantities of acetone, which was in urgent demand as a solvent for nitrocellulose, to be made into smokeless powder for the British and into airplane dope for the Americans.

Disguises must have a part in every detective romance, and in this particular one a deep disguise covered the blessing in the operation of this old distillery. Every time a pound of acetone was made, the microbe insisted upon accompanying it with two pounds of butanol, and although everyone wanted acetone, no one was at all interested in butanol. A little of it was used but the vast amount which had to be made was not only quite useless but to dispose of it was very troublesome. It would not burn satisfactorily and the fish in the rivers refused to accept it as part of their watery habitat. In this quandary the operators of the plant decided to save it by building immense vats in which to keep it against future need. One of these vats now serves as an admirable swimming pool and it is on this swimming pool filled with its unwanted contents that one leg of the American lacquer industry rests. This bit of economy was most fortunate, despite the cost of the vats.

The disguise was torn from the face of butanol when some chemists who had been much interested in

FIFTY-THOUSAND-GALLON FERMENTERS

The microbe gets seriously to work in great fermenters, each

FRACTIONATING COLUMN STILLS

Here

EXPERIMENTAL GAS UTILIZATION PLANT

ammo ... *the fermentors are ... a result of research*

smokeless powder discovered a method of making nitro-cellulose which would yield a solution thin enough to spread and thick enough to cover, as a varnish covers, the object to which it is applied. It was this kind of nitrated cotton which made possible our present-day industry in nitro-cellulose lacquers and it was this swimming pool full of butanol that furnished butyl acetate to serve as the essential solvent. It is somewhat doubtful if capital could have been persuaded to go into the large-scale manufacture of butanol which this new industry required without the benefit of the compelling proof of its fitness which this surplus furnished.

THESE two things, cheap butanol and low-viscosity cotton, are the foundations of the lacquer industry, whose phenomenal growth is among the most amazing of modern industrial wonders. Little more than three years ago, nitro-cellulose lacquers had been used only in small quantities as a protection of metal surfaces and for airplane wings, whereas today the department stores offer a dozen different varieties in dozens of colors and shades for household use and there are few automobiles made whose finish is not a lacquer. The quantities of lacquer used are increasing at a prodigious rate and, concurrently, the output of butanol has had to grow to supply the necessary solvent. Within the past 18 months, the butanol output has been more than doubled—it is now 60 tons per day—and a still further increase of an approximately equal amount is expected within another year.

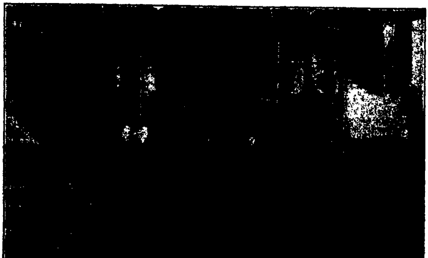
The effect of the lacquer, made from butanol, on the paint and varnish industry has been serious, but the wood distillers, already under an accumulation of difficulties, have found it hard to survive the manufacture and sale of the huge quantities of acetone produced as a by-product of this operation. The activities of the microbe result in the production of butanol (normal butyl alcohol), acetone, and ethanol (ethyl alcohol) in the ratio of 6:3:1, and thus the present unavoidable output of acetone amounts to some 30 tons per day. This must be absorbed by industry, and since no corresponding increase in use has been developed, it has operated to control acetone prices, acetone having formerly been one of the main dependences of the wood distillers for a profit from their operations.

The wood distillers and the Chilean nitrate industry are not quite in the same category but both have had their activities impeded by the delicate little microbe with the peculiar appetite. The wood distillers have been in the habit of supplying the world with five materials of importance and now their monopolistic hold on each has been loosened by cheaper processes.

The Chilean nitrate industry has long exercised a monopoly in supplying the world's farms with nitrogen for fertilizers, but in recent years synthetic ammonia has become a formidable competitor. Now, the synthesis of ammonia requires nitrogen, to be had gratis, or nearly so, from the air, and hydrogen, which is expensive. When our peculiar *clostridium* is comfortably converting starch into butanol and acetone, it breathes out great quantities of hydrogen, mixed with carbon dioxide from which it is easily separated, and so the latest effect of the microbe was the use of this hydrogen to make ammonia. Of course, the quantity produced by the microbe's help is not enormous, but every little bit added to the world's increasing output of synthetic ammonia sends a new shiver down Chile's back.

THE shift of emphasis from butanol, desired by the rubber synthesists to acetone, important during the war, and now back to butanol, a fundamental raw material for a new and very important industry, is characteristic of the kaleidoscopic changes constantly occurring in the rapid development of chemical industry. A useless by-product, expensive to dispose of today, often becomes overnight the valuable part of one's output. The changing face of affairs under such circumstances can only be met by continuous, energetic research. New ideas come so rapidly to an intensively thoughtful industry that no one can afford to be lulled into fancied security by things as they are, for they have an altogether too disconcerting way of changing.

The immense present size of the butanol industry, founded as it is on a micro-organism, and its further growth, must be a continuing source of wonder.



FERMENTATION PILOT PLANT

Many suggestions for improving yields in the large plant units are sent to this pilot plant for trial before adoption, to prevent needlessly upsetting commercial operations

Successful Inventors—VII

A Pioneer in the Telephone Art Gives Some Excellent Advice

By MILTON WRIGHT

"IN the field of invention the outsider often has better prospects of success than the man on the inside of a particular industry. I am assuming, of course, that the outside inventor has a fund of fundamental knowledge.

"Men who are too closely identified with a particular line of industry—who are working at it every day and possess all the existing knowledge there is about it—are likely to be too much concerned with details. A new idea does not occur to them when it is out of line with all the theories they have been working on. That scheme is branded as impracticable because it flies in the face of all the principles they have studied. In other words, they 'can't see the forest for the trees.'

"Also, the inventor who would be successful must not be burdened with too many facilities. When a man's resources are meagre he has to exert himself as the man with plenty of resources at his command never has to do. He has to stretch his imagination and his ingenuity to make up for the equipment he lacks. And because he works harder, he works more resultfully."

IT was Emile Berliner speaking—Berliner, the inventor of the microphone, the electrical transformer and the gramophone. His were the inventions which made the telephone practical. His was the invention upon which the Victor Talking Machine Company was founded. In the record of invention his name is carved deep. If ever an inventor's experience might serve as inspiration to inventors whose feet are still on the first rungs of the ladder, it is that of Emile Berliner.

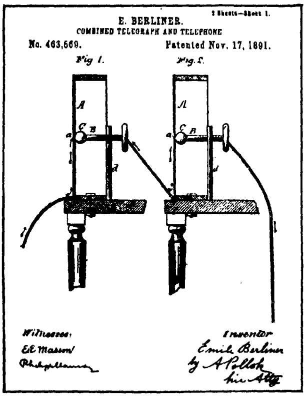
"I am indeed glad to see a representative of the SCIENTIFIC AMERICAN," he said when we visited him in his office in Washington, in the building he has erected for administering the child welfare work in the District of Columbia, to which he now gives most of his time and energy. "Your magazine was a great help to me when I was preparing for a career as an inventor."

"How long ago was that, Mr. Berliner?"

"That was back in 1874. I read it as part of my scientific education when I was attending Cooper Union in New York. With the hankering I had for scientific things, I read all the scientific literature I could lay my hands on."

"What started you on your first invention—the magneto telephone?" we asked. "Was it through coming in contact with people working along the same lines?"

"As a matter of fact, I had never seen Bell's telephone when I started



ONE OF BERLINER'S FIRST PATENTS

This covers the type of transmitter in which variations of pressure between two contacts vary the current flow

to work to make a transmitter in 1877," he replied. "But the telephone was being talked about. Bell had demonstrated it at the Centennial Exposition in 1876 and it was looked upon as one of the wonders of the age. I was clerking in a Washington dry-goods store, but I put in all my spare time experimenting with a telephone of my own contrivance.

"It is strange what little things will serve as a clue when you are groping for a new idea. One of the men I used to visit occasionally in those days was Alvan S. Richards, chief operator at the Washington fire-alarm telegraph office. I told him one day that I was learning to transmit messages.

"'Let me hear what you can do,' he said, pointing to a sending instrument not being used. I placed my finger on the key and started.

"'Hold on,' he exclaimed, 'that isn't right, you must press down on the key, not simply touch it. There must be a firm contact or your message may not be understood at the other end.' He went on to explain that in long-distance transmission, where the resistance is high, more current passes through the contacts when more pressure is used on the key.

"With that explanation I knew I had what I had been seeking. I went home, rigged up a diaphragm and made a contact with a steel button. I began to adjust it until the galvanometer showed that current was flowing. Then I pressed gently and I found that each time I pressed, the galvanometer deflected through a larger angle."

THUS Berliner hit upon the idea of the microphone. Hitherto the invariable rule with electromagnets was firm contacts. Discarding the old make-and-break principle, he converted a continuous electric current of any strength into waves, corresponding to sound waves with all their delicate variations, instead of letting the force of the voice produce a weak electric current as Bell was doing.

On April 14, 1877, he filed a caveat on his invention in the Patent Office, drawing up the document himself. Such a document—caveats were abolished several years ago—was a description of an invention filed in the Patent Office before the patent application was filed. Its purpose was to get an invention on record, in order to establish priority while the inventor was still working away on the details. In June he filed a regular application and in October of the same year Berliner filed his application for the continuous-current transformer.

"How did you commercialize your telephone inventions?" we asked.

"I got in touch with the Telephone Company of New York, a subsidiary of the then struggling Bell Company," he said, "and offered to sell my inventions. They turned down my offer

but invited me to go to New York and demonstrate what I had. One demonstration led to another, until Bell's associate, Thomas A. Watson, at a visit to me in Washington, said, 'We will want that, Mr. Berliner. You will hear from us in a few days.' Later I signed an agreement to turn over my caveats and patent applications, as well as the use of my induction coil or transformer patent. I received a modest salary and a royalty on all transmitters to be exported. Several years later the Bell Company paid me a lump sum and greatly increased my annual retainer. This took the place of salary, because I later went to work for myself."

"What do you consider the best time for an inventor to capitalize his invention—after he gets his patent or before?"

"After you perfect your invention, apply for a patent. As soon as you get a favorable action in the Patent Office, go to some big concern which would be interested, and lay your invention before the chief engineer. He will either tell you why, in his opinion, it will not work, or he will make you an offer. This is substantially the method I adopted and I think it is the logical one."

"BUT cannot better results sometimes be obtained by an inventor organizing his own company and selling articles covered by his patent?"

"Oh, yes. That is the method I pursued after I invented the lateral-cut disk gramophone record. There was keen competition. The American Graphophone Company had established a factory and was producing the Bell-Tainter graphophones and wax-covered paper-cylinder records. Edison, too, had invented his improved phonograph. It appeared to be practically the same apparatus as the graphophone, differing only in form and motive power.

FIRST BERLINER TRANSMITTER
This original model of the loose-contact microphone is now in the Smithsonian Institution at Washington, D. C.

"When you have something radically different from anything everybody else has—when you can accomplish something nobody else can accomplish—your prospects of making a commercial success are bright. What I succeeded in doing in the little laboratory in Washington which I opened up after I left the Telephone Company, was to 'etch the human voice.' By devising a disk gramophone record and working out a means of cutting it laterally at an even depth, I could get accuracy and purity of tone impossible with the cylinder records with their up-and-down cuts of uneven depth. More than that, however, I solved the problem of making unlimited copies of one original record.

"The tremendous commercial success of the talking machine is, of course, due in some measure to the genius of Eldridge R. Johnson, president of the Victor Talking Machine Company, who covered both technical and business fields. My part in it you may gather from the statement issued by the Victor Company several years ago as a warning to infringers."

We read this statement. It said:

"The manufacture and sale of the gramophone was first conducted by the United States Gramophone Company, followed by the Berliner Gramophone Company, and then by the Victor Talking Machine Company, which latter company acquired its rights from the former companies.

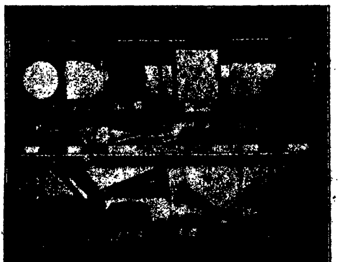
"We now control the original Berliner basic patents, and we have the gramophone developed to its present condition. Through our efforts and improvements, the gramophone has become an important factor in the market, in spite of the general opinion among talking-machine manufacturers, at the time of its advent, that it was destined to remain nothing more than a toy."

MINDFUL of the fact that Berliner's first inventions — those relating to the telephone—were made when he was 25 years old, and his next—those relating to the talking machine—when he was 36, we asked:

"When would you say an inventor is most productive—in youth or in later years when he has acquired a fund of knowledge and experience upon which to build?"

"The young man is the most prolific inventor every time," he replied unhesitatingly. "Most of the great inventions have been made by men between the ages of 22 and 27. More original ideas are evolved in youth than at any other time, but, of course, a man who is a born inventor keeps producing all his life."

Berliner, himself, is a born inventor. At 76 he is working away with



EVOLUTION OF THE GRAMOPHONE
as models of gramophones and the records used with them exhibited in the National Museum, in Washington, D. C.

Underwood and Underwood

FIRST COMMERCIAL GRAMOPHONE

©Harris and Ewing

... the
used to obtain good acoustics in auditoriums

MANUFACTURING ACOUSTIC TILE

They are built up on
properly placed and cc

all the enthusiasm of youth upon another invention just as revolutionary in the field of acoustics as any he perfected in days gone by. And it promises to be just as successful.

"What is the principle of this acoustic tile of yours?" we asked.

"Usually when an auditorium is treated for defective acoustics," he explained, "the walls are covered with some porous, sound-absorbing material, such as felt. This reduces the volume of all the bad sound, as well as the sounds you want to hear.

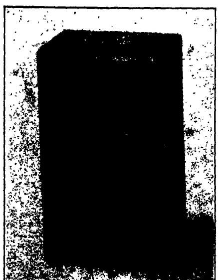
"On the other hand, wooden walls, especially pine or spruce, are ideal for auditoriums. They vibrate freely. Two of the best auditoriums I know of are the Mormon Tabernacle in Salt Lake City and the Wagner Theater in Beyreuth, Germany; the walls in both of them are of wood. It is logical to conclude that the cause of bad acoustics is the hardness or rigidity of the usual stone or concrete walls.

"MY remedy for bad acoustics is a process of covering a sufficient portion of the walls with a cement which combines the hardness and dignified appearance of a stone wall with the resonance of wooden panels. Such a cement I obtain, first, by mixing a porous material like asbestos, sawdust or pumice with ordinary cement, and then so shaping the tiles made from this mixture that, when joined to the wall, they form vibratory diaphragms. Here is the foundation of such a tile." He handed us a circular piece of wire netting laid over some sheets of coarse paper, about the size of a pie plate, but slightly convex. These are to be fastened to a wall, one beside another with the bulge out. The acoustic cement is then spread over the surface.

To get an idea of the effect of acoustic tile we went to the James H. Oyster School, where Berliner had treated the walls of the auditorium, notorious for its bad acoustics. The inventor took a tuning fork from his pocket, struck it on a radiator and set it against the brick wall. A dull sound resulted, hardly louder than the tuning fork gave when vibrating out of contact with anything. He struck the tuning fork again. This time he set it against a handsome cement panel containing his acoustic cells. Instantly a deep, loud, sweet tone responded.

"This is only a small auditorium," he said, "seating about 600. The acoustics have been so bad, however, with such echoes and distortions that nobody could understand anything. Now anyone in the back row can hear perfectly the recitation of a six-year-old youngster on the platform. About one quarter of the wall surface is treated—that is all that is necessary."

Back at the Health Center where



THE SOAP-BOX TRANSMITTER

This model of the loose-contact microphone is on display in the National Museum at Washington, D. C.

Mr. Berliner has his office, we had another demonstration. Down in the basement, which he has fitted up as a billiard room, he has lined the walls with acoustic tile. The floor is of wood, as is the floor in the hall leading into the room.

"LISTEN to your footfalls as you enter the room," said Mr. Berliner. We did. The moment we crossed the threshold the sound of our steps become louder and deeper, although our tread was no heavier. The acoustic tiles were responsible for the change. While we were with him, he received an acceptance of his offer to apply his acoustic cement cells in the trading hall of the New York Cotton Exchange.

A few days after we left Mr. Berliner, he informed us that he had just finished the large "Board Room" of the District Commissioners of Washington, which has suffered from bad acoustics for many years. Today that hall, which is 85 feet by 27 feet and 18 feet high to a vaulted ceiling, is so perfect acoustically that two people can carry on a conversation in an ordinary tone of voice from end to end.

"What would you say, Mr. Berliner, are the qualities necessary for an inventor?" we asked before we ended our visit with him.

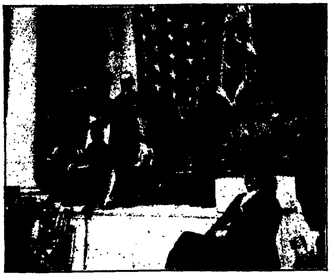
"To be an inventor," he replied, "a man must be a keen observer. He should have unlimited patience, and hundreds of failures must mean nothing to him."

"But how about marketing the invention? Does it not take as much real ability to make a financial success as it does to produce the invention?"

"After you have made something really worth while, success is bound to come. Manufacturers in every line always are eager for new inventions."

Wide World

WOODROW WILSON BROADCAST ONLY ONCE



Wide World

PRESIDENT COOLIDGE AT ARLINGTON

When the President Broadcasts

Harding Was the First Chief Executive Heard on the Radio— Coolidge establishes a record

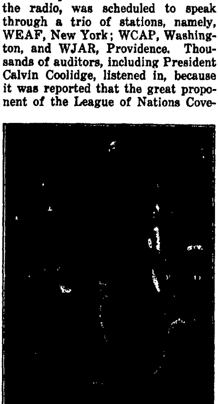
ORRIN E. DUNLAP, Jr.

FOUR years have passed since Warren G. Harding faced the microphone on June 21, 1923, in St. Louis, to deliver an address on the World Court, thus establishing a record as the first President of the United States to be heard by radio. Many will recall how his opening greeting, "My countrymen all," and his frequent reference to the "wide open spaces" of the west, sent through the ether from the lone transmitter of WEAF, afforded the public in the Metropolitan district their first opportunity to tune in the voice of a President.

"I SHALL not attempt to coerce the Senate of the United States," said Mr. Harding. "I shall make no demand upon the people. I shall not try to impose my will upon anybody or any body. I shall embark upon no crusades. . . . May our vision never be clouded by specters of disaster or shadows of dismay! If, in our search for everlasting peace, we but let lead and follow humbly but dauntlessly the 'kindly light' of divine inspiration to all human brotherhood, gleaming like a star in the heavens from the most beautiful of all hymns ever written, 'God will not let us fail.'"

Several weeks later, on August 2, 1923, President Harding died in San Francisco.

The utmost interest was manifest over another broadcast on November 10, 1923, when it was announced that ex-President Woodrow Wilson, whose voice the public had never heard over the radio, was scheduled to speak through a trio of stations, namely, WEAF, New York; WCAP, Washington, and WJAR, Providence. Thousands of auditors, including President Calvin Coolidge, listened in, because it was reported that the great proponent of the League of Nations Covenant and the man most responsible for the armistice would give his views on subjects suggested by the recurrence of Armistice Day and by its significance.



FIRST PRESIDENT TO BROADCAST

Warren G. Harding, delivering his first radio address in St. Louis in June, 1923

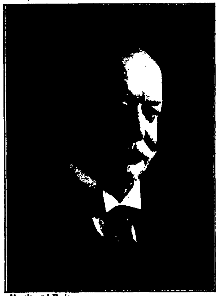
Radio impresarios, aware that this would be an historic occasion, because of the multitudes anxious to hear the voice of the wartime President, whose health had been wrecked, took every precaution to avoid interference. There was a common understanding between many of the important stations, not participating in the transmission of the Wilson speech, that they should sign off while Mr. Wilson was on the air.

THE Chesapeake and Potomac Telephone Company sent representatives to the Wilson residence on S Street in Washington with a specially equipped truck to which was attached the devices used in forwarding the voice over the telephone lines to the transmitters. The truck was stationed in the driveway beside the house and a trunk line was extended from the truck into the library on the second floor where the microphone was located. The amplifiers and other paraphernalia were on the truck where an engineer was on duty to regulate the amplification of Mr. Wilson's voice. From the motor car, the message was conveyed by an underground wire to WCAP and forwarded to the two other broadcasters.

The Washington announcer came on the air at 8:28 P. M., opening the circuit which switched in the microphone. Thus was opened the broadcasting system which was destined to send Woodrow Wilson's first public speech, addressed directly to the nation, since his collapse during the Peace Treaty ratification fight. Three minutes elapsed and the voice of the ex-President, a trifle husky at first but growing better as he proceeded, was heard by the radio audience in what proved to be the first and last radio address by Woodrow Wilson, who passed away on February 3, 1924.

Speaking to auditors throughout the east, the former President declared that the attitude of this country since the World War had been "deeply ignoble," "cowardly and dishonorable." He said that we had withdrawn from the affairs of the world "in sullen and selfish isolation," after our soldiers aided in winning the "war for right" and that the happy memories of those "never-to-be-forgotten days in November" of 1918 were "forever marred and embittered" for us by refusing to "bear any responsible part in the administrations of peace and establishment of the rights won by the war."

SINCE that occasion, President Coolidge has made good use of radio and has saved much time and effort by addressing the people through the microphone instead of taking long and tiresome train trips in order to speak to them. The Coolidge inauguration on March 4, 1925, will go down in history as the first ceremony of its kind to be broadcast. On that occasion, 27 stations from coast to coast were connected to the battery of microphones in front of the Capitol.



Harris and Ewing

HE BROADCAST FROM YALE

Ex-President Taft was heard on the air when he administered the oath of office to President Coolidge on March 4, 1925. His first radio address was radiated on April 20, 1927, when he spoke before a large audience in the Yale Club at Washington, D. C.

This record tie-up of transmitters was surpassed on February 22, 1927, when President Coolidge addressed a joint session of Congress assembled to pay tribute to George Washington, through a network of 42 broadcasters scattered across the nation from Portland, Maine, to San Francisco, California, reaching an audience estimated to be 20,000,000. So was formed a vivid contrast of the present time with the days when Washington's chief contact with the people was through small newspapers and letters to the leaders in each state.

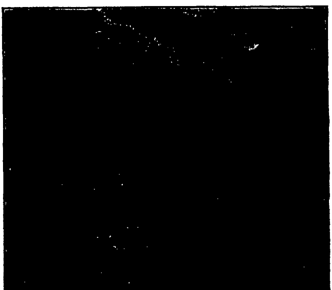
In addition to the regular broadcast, transmitters at WGY and KDKA sent the President's voice into space on short wavelengths which were detected in London, Paris and South Africa. The British Broadcasting Corporation rebroadcast the American waves from station 2LO so that listeners throughout the British Isles heard the President and the playing of "The Star-Spangled Banner" by the United States Army band, despite occasional interference and fading.

SIXTY Americans listened at the Savoy Hotel. They tuned in on the speech on eight-tube sets installed in their suites, and the last 15 minutes of the speech was broadcast through loudspeakers to 50 Americans who were dancing in the hotels.

"I had left my set turned on," said one American, "and was just coming down the corridor to the room when I heard the President's voice through the open door, yards away. It was so good that I could visualize him speaking."

The special wire circuits used to link the stations on this occasion covered approximately 10,000 miles and required the attention of 200 telephone engineers—two men at each of 53 repeater points and 37 terminal points and 20 at the central office at 24 Walker Street, New York City, the nucleus of the network. In addition, more than 200 radio engineers were on duty, since five or more men were occupied with the transmission of the program at each of the 42 stations. In this manner, chain broadcasting achieved a new record, while enabling President Coolidge to speak to the people of the United States in honor of the 200th anniversary of George Washington's birth.

The circuits utilized for connecting the broadcasters for simultaneous



Courtesy of American Telephone and Telegraph Company

REPEATER INSTALLATION AT PRINCETON

These repeaters or amplifying relays are located at various points along the radio wire network, so as to maintain the signal strength delivered to the various stations

Herbert Photo

SWITCHBOARD AT CENTRAL STATION

The operators at WEAF's speech-input control board, control volume and route the voice currents over the network's land lines, thus insuring proper transmission from all points

transmission consist of telephone lines especially adapted for the purpose. While the ordinary long-distance telephone wires may carry at the same time four or five telephone messages and numerous telegraphic communications, a "special circuit" for radio broadcasting must be cleared of all other traffic. Also, the broadcast circuits must be equipped with special vacuum-tube repeaters or amplifiers, since the ordinary repeaters used in long-distance telephone work are not designed to cover at one time the wide range of frequencies that are involved in the broadcasting of music and of speech.

In addition to the telephone circuits over which the program is transported, another line paralleling the first is employed to keep all stations in the network in constant communication with each other by telegraph. In this manner, the condition of the various circuits is checked at regular intervals to make sure that every word or every musical note of the program is reaching all stations in the system with good intensity and free of extraneous noises.

The detailed routing of the President's address and other events of national importance begins with six circuits which leave the telephone headquarters at 24 Walker Street, New York City, in different directions. New England stations are supplied through two circuits, one traveling direct to Springfield, Massachusetts, to WBZ; the other passing through Hartford, Connecticut, where WTIC is located, then on to Boston, where WEEI is supplied, and to Portland, Maine, where the program is fed to the transmitter of WCSH. Taps at Hartford connect with WTAG at Worcester, Massachusetts, and with WJAR at Providence, Rhode Island.

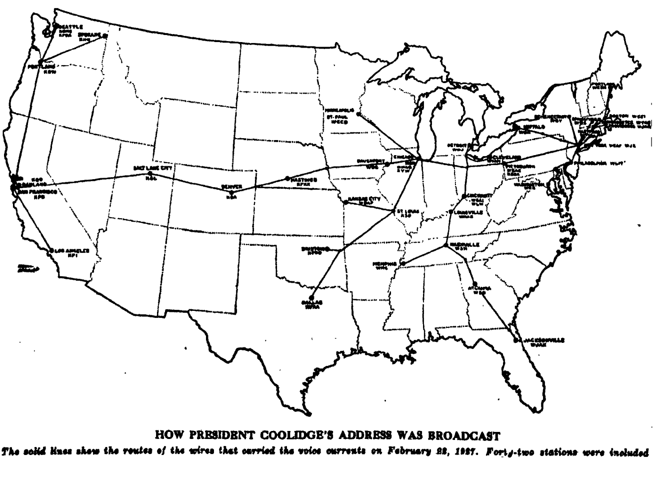
The third main line from New York carries the program to WGY, Schenectady, and the fourth passing through Scranton, Pennsylvania, and Elmira, New York, leads to WGR at Buffalo. Still another circuit parallels the incoming wire from Washington, running through Philadelphia, where it supplies either WFI or WLIT and then continues to Washington to feed WRC.

The sixth main circuit from New York travels west to Brushton, Pennsylvania, where a tap emanates to KDKA and WCAE in Pittsburgh, and passes on to Beaver Dam, Ohio. From this point a connecting circuit extends north through Maumee, Ohio, where a tap supplies WTAM at Cleveland and then goes on to WWJ at Detroit. Traveling south to Beaver Dam, another line runs through Cincinnati, Ohio, (WSAI); Louisville, Kentucky, (WHAS); Nashville, Tennessee, (WSM); Memphis, Tennessee, (WMC), and so on through Chattanooga to Atlanta, Georgia, (WSB), and Jacksonville, Florida, (WJAX).

Beaver Dam is connected also by special circuits with Morrell Park, Illinois, located near Chicago, and from that point the transmitters of WGN, WEBH, WMAQ and KYW are fed. A circuit running north from Morrell Park connects with WCCO in Minneapolis, Minnesota, and another traveling south reaches St. Louis, Missouri, (KSD); then to Kansas City, Missouri, (WDAF); Bristow, Oklahoma, (KVOO), and Dallas, Texas, (WFAA).

West from Beaver Dam, WOC at Davenport, Iowa, is supplied by a circuit which continues on through Omaha, Nebraska, to Hastings, Nebraska, (KFKX); Denver, Colorado, (KOA); Salt Lake City, Utah, (KSL), and then on to San Francisco, where KPO is supplied with the program. Station KGO, Oakland, California, is fed direct from San Francisco by a special line. Another channel passes south to Los Angeles (KFI), and another extends north to Portland, Oregon, (KGW), from which point a tap emanates to Spokane, Washington, (KHQ). Then continuing north from Portland through Tacoma, Washington, wires connect with KOMO and KFOA in Seattle.

Thus, a broadcast event originating in the east is spread across the continent; the Capitol is linked with the nation and the voice of the President is within reach of an international audience.



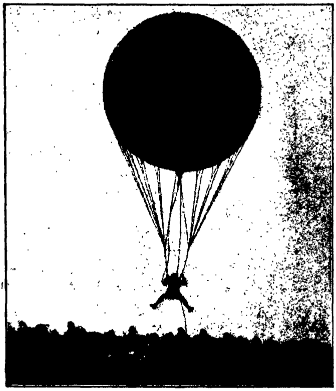
HOW PRESIDENT COOLIDGE'S ADDRESS WAS BROADCAST

The solid lines show the routes of the wires that carried the voice currents on February 22, 1927. Forty-two stations were included

Photographs by P and A

PREPARING FOR A JUMP

The "jumping balloonist" is adjusting his ballast and harness before venturing to leave the ground in an initial jump



OVER AN AUTOMOBILE

From a drawing made specially for the Scientific American

CROSS-COUNTRY JUMPING WITH SMALL BALLOONS

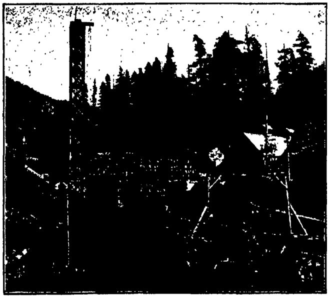
Our artist has here shown the possibilities of the new sport of balloon jumping. At a single bound, it is possible to cover a distance of 100 yards or more, when unhindered by wind. An ordinarily strong jump will send the jumper 40 feet into the air

Small Balloons Provide New Sport

Using a balloon having a capacity of about 3500 cubic feet, and equipped with the proper harness, it has been found possible to make enormous jumps with no motive power other than that of the jumper's muscles and any slight breeze that may be blowing. The balloons, as illustrated above, are fitted with a rigging and body harness similar to that used on a parachute. The jumper carries a certain amount of ballast with him, which can be used to control the lift of the balloon. For short jumps, a light yet strong rope attached to the balloonist may be held by those on the ground, or otherwise fastened, thus preventing the jumper from traveling far. When starting, the ballast and the gas in the balloon are so balanced that the gas-bag itself supports all of the jumper's weight with the exception of about four pounds. With this effective lightness, the aeronaut can jump many feet into the air, and by properly pushing himself at the take-off, can, to a great extent, govern the direction in which he will travel. To rise still higher, ballast can be released, while in the event of being carried off by a sudden wind, a valve is conveniently located so that gas can be released and buoyancy lost. There is a great possibility for competitive sport here, using these balloons for racing, high jumping, and similar contests.

EAST PORTAL AT BERNE

A short piece of track connects the east entrance with the main line. A one and one-half mile fill was made with debris from the tunnel



TUNNEL ENTRANCE AT WESTERN END

Here are shown the first forms that were laid for the concrete. Included in the photograph are the West Portal shield and tunnel entrance

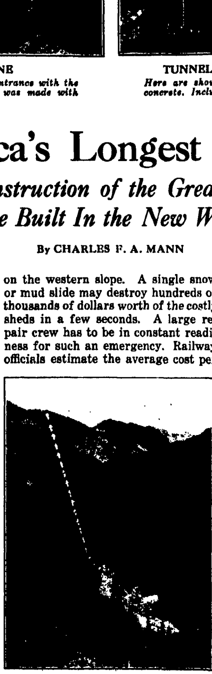
America's Longest Tunnel

Rapid Construction of the Greatest Tunnel to be Built In the New World

By CHARLES F. A. MANN

ONE of the most important pieces of engineering in progress at the present time in the United States, is the boring of the new eight-mile tunnel through the Cascade Mountains in Washington by the Great Northern Railway. The new tunnel when finished will be exactly 7.79 miles long and will be cut on a tangent across the Cascades from Scenic to Berne. When completed it will be the longest tunnel in the western hemisphere and the fourth longest in the entire world, exceeded only by the mighty cuts through the Alps between Switzerland, France and Italy.

The problem of crossing the Cascades has been an important one to engineers ever since the opening up of the Puget Sound country 70 years ago. The problems here are peculiar, inasmuch as the Great Northern, like other northwest roads, crosses the Columbia River in central Washington at an altitude of 608 feet above sea level and climbs to an altitude of 3,381 feet in 71 miles. At the summit of the Cascades the line descends sharply to an altitude of only ten feet at Everett, on Puget Sound, giving a rise and fall of well over 3,000 feet in 140 miles. In addition to the sharp grades and many curves, the lines are in constant danger in the winter months from the tremendous snowfall on the western slope. A single snow or mud slide may destroy hundreds of thousands of dollars worth of the costly sheds in a few seconds. A large repair crew has to be in constant readiness for such an emergency. Railway officials estimate the average cost per foot of these snow sheds at around 150 dollars.

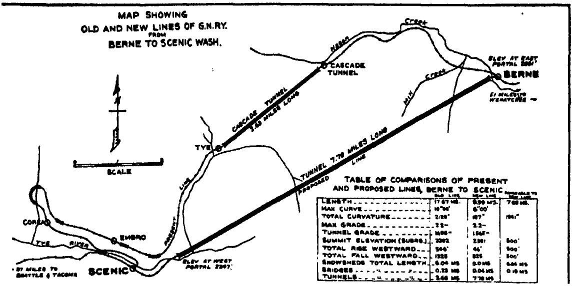


WEST PORTAL FROM THE AIR

The arrows show the route chosen for the bore through the mountain. The eight-mile tunnel will cut off eight miles of track and six miles of tunneling and snow sheds. This photograph was taken from a peak just northeast of Scenic

Summing up the problem as a whole, the engineering department of the Great Northern decided that in order to eliminate the heavy annual expense of hauling traffic over the mountains, and to speed up the service, a shorter route must be found. Accordingly, a surveying party was sent into the mountains early in 1925 and after a careful survey of hundreds of square miles of rocky country, selected suitable portal sites for a new tunnel at Berne on the east side and Scenic on the west. The comparatively small difference in elevation of Scenic and Berne made it possible to construct a tunnel with a 1.565 grade descending from east to west, with a total length of 41,136 feet and costing ten million dollars to build. The new tunnel will benefit the system in six ways:

1. It will eliminate the annual maintenance charges for renewal of snow sheds and the heavy expense of operating rotary snow plows through the snow belt.
2. It will afford permanent protection from snow slides and will eliminate the six miles of snow sheds.
3. It will reduce operating costs brought about by heavy grades requiring helper engines.
4. It will lessen the distance by several miles.



5. It will eliminate the excessive curvature in the Martin Creek loop.

6. It will lower the summit elevation by 500 feet and lessen the total rise and fall. It is estimated that when the new line is opened, four hours will be cut from the schedule of freight trains and that 17 train crews can be done away with.

After months of careful planning the Great Northern contracted with A. Guthrie and Company of St. Paul for actual construction of the tunnel. Immediately both organizations joined forces and built three camps, which are the finest ever built for caring for men working on a project of this kind. Model cities were built at Scenic and Berne, equipped with electric light and heat, sanitary sewage-removal systems, and running water.

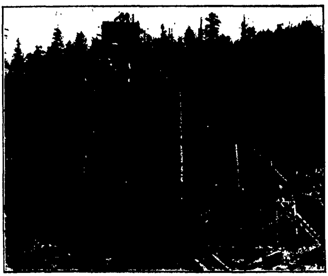
Everything is furnished all camps in order to make them as comfortable as possible, and special quarters are furnished married men with families. Indeed, a modern electrically lighted and heated school was built high up in the mountains for children of the workers. The bitter lesson of other large tunnel jobs pointed to the fact that every precaution must be taken in order to complete the bore by November, 1928, before the snows begin.

ACTUAL boring started early in 1926 and it was decided to use what is known as a pioneer tunnel paralleling the main bore. This runs from the west portal to the Mill Creek shaft, or for nearly six miles. The Mill Creek shaft was sunk about two and one-half miles west of the east portal, at what is known as Mill Creek valley. It is carried down 622 feet below the floor of the valley to subgrade of the main bore. Drilling and mucking operations are going ahead from both faces on the pioneer cut and the main tunnel. No pioneer tunnel has been run from Mill Creek to the east portal on account of the short distance and because all operations eastward are upgrade. Should excessive water inflow occur, all uphill operations could be stopped and there would be practically no necessity for extending the time. Using this system involves much extra expense; but where the work is done against time the saving will well repay the extra work. Cross cuts are made every 1,500 feet, and when finally all openings are being drilled there will be from 10 to 20 double-faced workings instead of two. Furthermore, this will give two outlets for air, water, light, ventilation and rail lines and will care for excessive inflow of water, one tunnel being plugged to handle water only.

The main center heading, which procedes the enlarged section, is 10 by 10 feet in size and is later enlarged by the top heading and bench methods to the full size of 18 by 25 feet. Separate crews timber the cut, and lastly the concrete lining is poured in at the rate of about 25 feet per day. The pioneer cut is 8 by 9 feet in size and is unlined. The method of cutting

A WORLD'S-RECORD CREW

These men bored through 1,157 feet of granite rock in 29½ days. The former record was a cut of 984 feet in 30 days, made in 1918



SHAFT-HEAD AT MILL CREEK

A shaft drilled to the grade of the main tunnel about two and one-half miles west of East Portal provided three exits instead of

away the rock face, which is a varied mixture of fundamental gneiss and calcarious schist with occasional strata of hard fine granite, is interesting for its speed and accuracy. From 20 to 30 holes nine feet deep are drilled into the rock face by a set of drills mounted on a movable drill carriage braced against the rock. The holes are one and one half inches in diameter and are constantly kept free of dust by a stream of water flowing through the drill rods.

AFTER the holes are carefully tamped full of measured charges of blasting gelatin, the men and equipment are moved back about 2,000 feet and the charges are set off in five separate blasts. First the middle core is blasted. Another charge enlarges the loosened layer to a large cone; another loosens the outer edge; and one charge lifts the entire mass from the back face. Lastly a heavy charge blows the entire loosened section clear of the roof and floor. Automatic electric muckers scoop the debris into conveyors and drop it into mine cars. This cycle is repeated five or six times in 24 hours and it never stops from one month's end to another. The underground workers are supplied with hot food, and telephone communication is available clear to the face of the workings. Strong flood lights make the work a veritable movie studio, and there is less physical inconvenience than would be incurred in digging a large cellar where such details are overlooked.

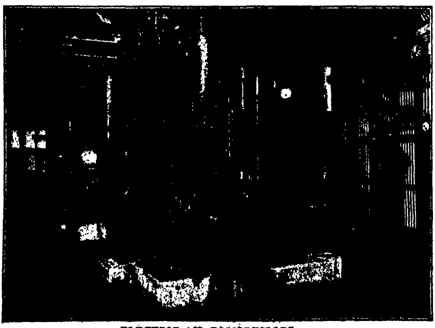
A MYERS-WHALEY MUCKING MACHINE

Four men operating one of these machines can remove as much debris as could formerly a dozen men and a string of mules. The machines operate by electricity and can run in a five-foot tunnel

From 40 to 50 feet per day is rated as excellent progress for the drill gangs and nearly two miles of pioneer tunnel have been driven. Concreting has been started at the west portal and is now in nearly 300 feet. Recently the world's record for drilling an 8 by 9-foot hole was established by a crew at the west portal. They drilled 1,157 feet in 29½ days through hard granite. The former record was held by a crew on the Rodgers Pass tunnel in British Columbia in 1913 when they cut a passageway through a distance of 954 feet in 30 days.

Contrast this marvel of engineering efficiency with the methods used in boring the world's first long tunnel nearly 2,000 years ago. It was built by the Emperor Claudius in 52 A. D. for the purpose of draining lake Fucino in Italy and was four and one-quarter miles long. It required the labor of 30,000 men for 11 years. Modern methods would have holed this tunnel in six months with 400 men and some compressed air and electricity.

When the two sections meet sometime early in 1928, the Great Northern will open a new era in transportation in the Pacific Northwest. Traffic to Puget Sound has increased by leaps and bounds. The heroic task of moving the heavy freight and passenger trains over one of the worst sections on the 2,000-mile journey westward from St. Paul will be much easier, and "on time schedule" will be easier to maintain than ever before in the history of the road.



ELECTRIC AIR-COMPRESSORS

In order to keep the air-operated drills constantly at work, it was necessary to provide compressed air at a pressure of 180 pounds per square inch. The machines shown above handled all requirements

THE new tunnel marks the beginning of a long series of improvements which not only the Great Northern but other railroads are forced to make to maintain their standards under the pressure of modern traffic, and it is in keeping with the policies of other railroads of the country which, during the last 15 years, have spent hundreds of millions on eliminating curvature and grade. The new tunnel will eliminate over five complete circles of curvature or nearly 2,000 degrees.

Ever since the days of the famous switchbacks, which were first used in the Cascades to raise the trains over the mountains, the Great Northern has found snow to be its worst enemy. It now bids fair to ban the soft white monster forever.

This great work is being done under the personal direction of Colonel Frederick Mears, Seattle, with Mr. M. J. C. Andrews as Engineer in Charge on the work.

Stupendous Pressures

Pressures of Great Magnitude Profoundly Alter the Properties of Matter. How Extreme Pressures are Produced in the Laboratory

By P. W. BRIDGMAN, Ph. D.
Professor of Physics at Harvard University, Member of the National Academy of Sciences

The author, whose experiments with high pressures have opened an interesting field

THE pressures of ordinary experience may be arranged according to orders of magnitude in some such way as this. First, pressures of the order of tens of pounds per square inch, of which the pressure of the atmosphere is the most familiar. Next, pressures of hundreds of pounds per square inch, such as are met in steam engines or the explosions of gas engines. Next in order are pressures of thousands of pounds, such as we find in cylinders of compressed gas, which usually measure 2000 or 3000 pounds, or in hydraulic machinery, which sometimes operates to 5000 pounds. The next higher order is that of tens of thousands of pounds. Of this, the most familiar example is artillery, which operates usually at not more than 30,000 lb/in^2 (pounds per square inch). The pressure at the bottom of the ocean at its deepest part is in the neighborhood of 15,000 pounds.

The next higher order is that of hundreds of thousands of pounds per square inch. A number of years ago I devised methods for handling pressures of this order, and have been able to reach in the extreme case as much as 600,000 lb/in^2, although most of my work has been limited to more modest pressures of 200,000 lb/in^2. One may visualize a pressure of 200,000 lb/in^2 by imagining a 100-ton locomotive supported on a pin one square inch in cross section.

UNDER pressures of the order of hundreds of thousands of pounds, many of the properties of matter are profoundly altered, and there are many phenomena of great physical interest to be measured. But before entering on a systematic investigation of this field of high pressures it is evident that there were a great many new preliminary problems to be solved in the production, handling, and measurement of such pressures. I have thought that the readers of the SCIENTIFIC AMERICAN would be interested in hearing of some of the preliminary steps, since a great many interesting things were found in the preparatory work.

In the first place, this whole high-pressure field was opened somewhat by accident. I was engaged in an optical experiment under the quite modest pressure of 1000 lb/in^2, where one of the problems was the designing of a packing plug for a hole. On examining the plug after it was designed, I saw that incidentally it did very much more than was necessary, for it was such that it automatically became tighter as pressure increased, and thus could never leak, no matter how high the pressure, provided only that the walls of the containing vessel did not break. This packing at once opened an enormous field, for the highest pressure reached in previous research was about 45,000 lb/in^2, and the limit was set by leaks, and not at all by the strength of the containing vessels.

FIGURE 1

General principle of the packing by which the pressure in the packing B is always kept higher than that in the liquid at L

The magnitude of the field opened is shown by the fact that now after nearly 20 years' work I do not feel that I have much more than begun. The situation presented by the discovery of this new principle in packing was one of the few occasions where persistence in research is not a virtue. I immediately dropped the original problem to cultivate the new field, and have not yet had a chance to return to it.

The fundamental principle of the packing is shown in Figure 1, where is represented the method by which a piston is packed. The figure shows a piston (P) forced into a cylindrical hole in a steel block, compressing the liquid (L) with which the hole is filled. (R) is a ring of hardened steel, (C) is a cup-shaped soft-steel washer, (B) a packing of soft rubber, and (A) a mushroom-shaped piece of heat-treated steel. The essential feature is that the stem of the mushroom does not reach entirely through the ring (R), but its end is unsupported. This means that the entire push of the piston (P), which, of course, is equal to the pressure in the liquid except for friction, is transmitted to the mushroom through the packing (B). Now the area of this packing is less, by the area of the stem, than the total area of the piston, so that the pressure in pounds per square inch in the packing is greater by a fixed fraction than the pressure exerted by the piston and in the liquid. Hence the liquid can never leak *out* past the packing, but paradoxically, since the pressure in the packing is greater than that in the liquid, it is the packing that tends to leak *in* past the liquid. Any such inward leak of the packing can easily be prevented if the plug is a close fit for the cylinder.

IN practice, the stem of the mushroom is usually about one-half the diameter of the head, so that the area of the stem is one-quarter of the area of the head, and the area of the ring on which the packing pushes is three-quarters of the area on which the liquid pushes, and therefore the pressure in the packing is always 33 percent greater than that in the liquid. Thus if the pressure in the liquid is 30,000 lb/in^2, that in the packing is 40,000 pounds, and when the pressure in the liquid becomes 300,000 pounds, that in the packing rises to 400,000 pounds.

It is an interesting comment on the vagaries of patent law that a patent for this packing was refused because it had been previously used on the plunger of a sausage machine.

Having now this means of producing any pressure without leaks, the

FIGURE 2

One of the halves of a cylinder of tool steel split by the application of internal pressure. The inner hole has stretched from one half to one and one fifth inches. The maximum pressure withstood by this cylinder was 600,000 pounds per square inch

first question was to find how high pressures could be reached without bursting the walls of the containing vessels. Of course, one does not double the strength of a cylinder by doubling the thickness of the walls, and engineers had long known that there is a practical limit beyond which it does no good to increase the thickness of the walls. The reason is that the inner fibers of the cylinder have to do by far the largest part of the work of supporting the internal pressure, since the more distant outer layers cannot help in supporting the pressure until the strain is propagated to them by the inner layers stretching far beyond their elastic limit.

ALTHOUGH no experiments had been made to find just how much pressure a very thick-walled cylinder would support, there were various theories, and these all agreed in saying that the maximum pressure possible was about equal to the ordinary breaking strength of the metal. Thus a cylinder made of ordinary mild steel of a tensile strength of 60,000 lb/in² would not be expected to support more than 60,000 pounds internal pressure, even if the walls of the cylinder were infinitely thick. Very fortunately, this estimate of theory turned out to be much too low. The fact is that in a thick-walled cylinder the inner fibers are so supported by the outer fibers that they can stretch very much more without breaking than they can under the conditions of the ordinary tensile tests, and so allow the outer fibers to assume a greater share of the load than was thought possible.

This possibility is shown in Figure 2, which is a photograph of one of the halves of a cylinder of ordinary tool steel broken by an internal pressure of 600,000 lb/in². The tensile strength of such a steel is not more than 150,000 pounds, so that this cylinder actually supported four times as much pressure as the simple theory indicated. The photograph also shows the great stretch of the inner fibers; their elongation was 140 percent, whereas not more than 25 percent is possible under ordinary conditions. Most paradoxical of all, the cylinder broke at the outside surface, where stress and strain are both least, instead of at the inner surface, where both stress and strain are a maximum. Such phenomena evidently give very important light on the theories of rupture of metals, into which, however, there is not space to enter here.

In Figure 3 and 4 are shown two other examples of cylinders broken by internal pressure. Figure 3 is a cylinder of mild steel, the maximum strength of which under ordinary tensile tests is 60,000 lb/in², which required over 200,000 lb/in² to break it as shown. The inner hole was stretched from ½ to 1⅜ inches, or 175 percent. Figure 4 is the cross section of a cylinder of copper; this required 150,000 lb/in² to break it, against a breaking strength in ordinary tension of 30,000 lb/in². The inner hole stretched 200 percent, from ⅛ to ⅜ inch, before rupture took place. Notice that in copper the rupture traveled in from the outside along a sort of spiral; this is quite characteristic.

IF a heavy cylinder is stretched beyond the elastic limit, so that the internal layers receive a permanent stretch, and pressure is then released, the cylinder is put into a condition of internal stress very much like that in a built-up gun, in which there is compression at the inner layers and tension at the outside, except that the distribution of stress is very much

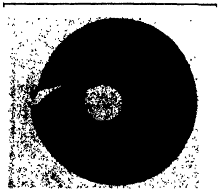


FIGURE 4

Cross section of a copper cylinder burst by the application of internal pressure. The inner hole was stretched from ⅛ to ⅜ of an inch

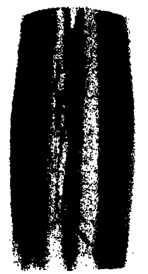


FIGURE 3

A cylinder of mild steel ruptured by excessive internal pressure. This cylinder was originally two inches in outside diameter and one half inch in inside diameter. The inner hole was stretched until it measured one and three eighths inches in diameter

more uniform than that possible to reach in a gun by shrinking on hoops. This principle offers a very much better and cheaper way of constructing large artillery; experimental guns were made by this method during the war, and now such guns are in regular construction.

Another problem on which much thought was expended was that of the piston by which these high pressures were to be produced. Many designs of elaborate apparatus were made, in which I attempted by various features of design to make the average compressive stress in the piston less than the pressure which it produces in the liquid. Fortunately all such elaborate schemes proved unnecessary because the strength of steel for the simple compressive stress which the piston must support turned out to be much higher than expected. Steel, when glass hard, can support an astonishingly high compression, although for most purposes glass-hard steel is much too brittle.

MANY different grades of steel were tried; any high-carbon steel that can be made glass hard will support 450,000 lb/in² or more, and I found one steel that required 750,000 lb/in² to break it in pure compression. My experience with the piston emphasizes the enormous value of simplicity in design. The results of my experience can now after many years be reduced to an extremely simple receipt for producing the highest possible pressures: Take a strong piece of steel, bore a hole in it, fill the hole with a liquid and close the hole with a plug that will not leak, and push as hard as you can on the plug.

Another problem was to devise a method for piping a liquid under high pressure from one vessel to another, for obviously the experimental methods can be much simplified if the apparatus can be made in several parts connected by pipe. This was brought forcibly home after spending a month constructing a complicated apparatus of one piece of steel to avoid connecting pipe, and then having it break on the first application of pressure because of a flaw in the center of the ingot. The difficulty of flaws in the metal proved very serious, for, as may be imagined, pressures

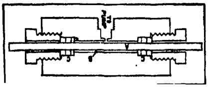


FIGURE 5

Apparatus for producing the "pinching-off" effect, that is, separation of the longitudinal fibers by the application of pressure to the curved surface of a cylinder. The specimen is shown at A. The fluid exerting the pressure by which rupture is produced is contained in the annular space at B

as high as these will find out the minutest flaws. This particular difficulty has become much less serious in the last few years with the introduction of sound steel made in the electric furnace.

To return to the pipe, it is possible to obtain commercial steel capillary tubes with an external diameter five times the internal diameter, but such tubes will not stand permanently more than 60,000 lb/in². The difficulty was finally met by working out a method for drilling the connecting tubes from the solid rod; I have made such tubes with an internal diameter of 1/16 of an inch and 18 inches long.

THE early work was not without a certain amount of danger, explosions continually occurring, and pieces of steel flying about with velocities sometimes high enough to penetrate six inches of hard pine planking. These dangerous ruptures were finally found to be all of the same type, and to involve a possibility not previously recognized. This type of rupture was afterward studied for its own sake; in Figure 5 this sort of rupture is illustrated. The rod (A) passes completely through a high-pressure cylinder, coming out through stuffing boxes (C), and within the cylinder its external curved surface is exposed to hydrostatic pressure exerted by a liquid in the annular space (B). When the pressure in the liquid rises high enough, the rod parts in the center just as if it had been pulled apart by a tensile load, and the two parts of the rod are expelled through the stuffing boxes with much violence.

In Figure 6 is shown one of these pinched-off rods; the pinching took place at the pointed end. For safety, the rod was expelled into a hole in a massive block of steel. The violence of the expulsion is suggested by the fact, which can be easily detected in the photograph, that the diameter of the rod was appreciably enlarged for at least one third of its length.

The paradoxical feature of this sort of rupture is that there is no *force* lengthwise of the rod tending to make it break, but nevertheless the fibers are lengthened in this direction and eventually break. The effect in principle is much like pinching off a roll of putty between the fingers, only here the putty is solid steel, and the fingers which pinch it are a mobile liquid. The importance of such a type of rupture for the theories of the engineer is evident.

A VIEW of one of the finally evolved pieces of apparatus which has been in constant use for many years is shown in Figure 7. Pressure is produced in the upper cylinder (A) by a small piston (B) (½ inch diameter) driven by the larger piston (C) (2.5 inches in diameter) of a hydraulic press, which in turn is operated by the hand pump (D). By means of the valves at (E), the pump (D) may be connected at will to the piston (C), or to the small hydraulic intensifier (H). The intensifier is used to produce in the high pressure parts of the apparatus an initial pressure of 30,000 lb/in². This initial pressure compresses to negligible volume any air accidentally present in the apparatus, and also takes up a large part of the compressibility of the liquid, thus making it possible to reach 200,000 lb/in² with a single stroke of the high pressure piston,

FIGURE 7

A photograph of a standard high-pressure assembly. The letters are explained in the text directly above

which could not otherwise be accomplished because of the necessary absence of all valves in the high pressure part of the apparatus. The upper cylinder (A) is connected through the pipe (F) with the lower cylinder (G), which may be removed and altered to suit the experiment.

PERHAPS an unexpected feature of the apparatus is its small size, the cylinders being not over five inches in diameter. There is a real reason for this, because only the strongest steel will stand these pressures, and steel must be heat treated to bring out its greatest strength, and only small pieces of steel can be heat treated throughout their entire mass.

With this apparatus a great many new phenomena have been investigated which there is no space to describe here. Most of these phenomena have been accurately measured.

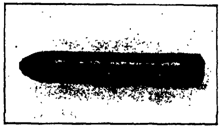


FIGURE 6

A "pinched-off" rod. Notice the upsetting of the diameter for a third of the length of the rod, suggesting the extreme violence of the effect

Some of them, however, were of interest primarily because of their bearing on the design of the apparatus, and these were investigated only qualitatively. Thus it was found that no steel cylinder will support more than about 90,000 lb/in² without rupture, when the pressure is transmitted to it by mercury. The reason is that the atoms of the mercury, which are very small, are driven by the pressure between the atoms of the steel, where they amalgamate it. Another surprising effect is that many substances normally soft and pliable become enormously hard and stiff under pressure. Thus it is not possible to transmit a pressure of more than 60,000 lb/in² with ordinary oil, because the oil becomes so stiff that it no longer flows under pressure. Paraffine wax is made by pressure harder than ordinary machine steel; it is quite easy under high pressure to make a piece of steel flow by pushing it with a piece of paraffine. Soft rubber acts in the same way and becomes very hard. Sometimes a soft rubber washer becomes so brittle that it cracks under pressure, and then the soft steel in contact with it is forced in ridges into the cracks in the rubber. That is, under high pressure soft rubber becomes so hard that it may be used as a die to form steel.

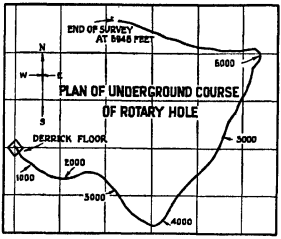
The Wanderings of An Oil Well

Automatic Surveying Machine Shows World's Deepest Well to be 517 Feet Out of Plumb at 6,000 Feet Depth

IT is probable that the men who rush off to a newly discovered oil district, put up a derrick, and begin to bore for oil, believe that they are driving their drills vertically into the ground beneath them. If the drill should not go where it is pointed, it would be a serious matter for these adventurers, for the derrick is erected and the drilling is started upon a plot of ground which is selected under the belief that the quickest way to get at the oil is by a vertical well running straight to the supposed oil reservoir below.

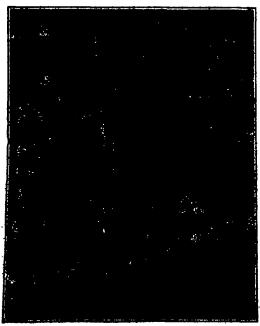
Not all of the experienced well drillers, and certainly not the trained mining and petroleum engineers and the geologists, have such a simple faith in the good behavior of the oil drill. These expert men are well aware that the progress of the drill on its way down to the oil-bearing sands is apt to be somewhat erratic; but none of them was able to determine the extent or the direction of these deviations from the vertical. If the well hole had only been big enough to allow one to descend, carrying with him a level, inclinometer and compass, it would have been a very simple matter to plot the deviations, both in the vertical and the horizontal plane, but this, of course, was impossible; the diameter of the well was altogether too small for that.

It was reserved for a well-known mining and petroleum engineer, Mr. Alexander Anderson of Fullerton, California, to design a small and very ingenious instrument that is capable of making such a survey. It is so small that it can be lowered bodily into the drill hole, and so accurate that, in its course down to the bottom of the well, it automatically records and photographs on a reel of film its exact position at any desired depth.



The survey machine proper consists of a tube, 3½ inches in diameter and 7 feet long, as shown in the accompanying photograph. At its lower end is a conical plug welded into the tube. At its upper end, a top plug is welded into the tube, and this connects by a coupling to the tool joint pin at the bottom of the drill pipe. Attention is directed to the photograph showing the head of the well. At the back of the picture are seen several lengths of drill pipe, each section being 85 feet long. In the center at the top of the picture is the end of the main drill pipe, (the drilling machine, by the way, being of the rotary type,) and below this the pipe reduces in diameter until it is screwed into the top of the survey machine, which will be noticed projecting somewhat above the mouth of the drill hole. The man to the left is standing upon the circular drill table, gear-driven, by which the boring bit is operated. The man in the center is screwing the survey machine into the tool joint pin by means of a sprocket wrench. When the coupling up of the survey machine has been completed, successive lengths of the 85-foot pipe will be screwed on as the machine is lowered into the well. At stated intervals the recording apparatus within the little tube will make a photographic record of the inclination and of the variation in azimuth of the survey machine at successive levels.

Now, consider the photograph shown in the bottom right-hand corner of the page. This is a demonstration frame which serves to show the method of operation of the survey machine. The 7-foot 3½-inch tube is supported by three rods upon a circular ring baseplate. Note the screws passing through the lower flange of



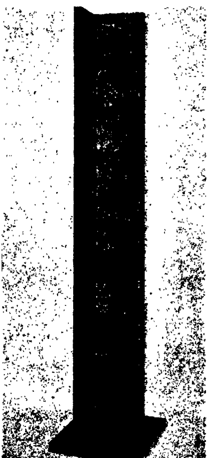
TOP OF WELL

LEFT: *This shows top of well. Drillers are attaching the tubular surveying machine to bottom of drill pipe. Note group of "stands" ready to be coupled on as the pipe is lowered into the well*

THE OUTFIT

RIGHT: *The inventor demonstrating the operation of the surveying machine. It is so mounted on a tripod that it can be given movements similar to those which occur when it is lowered into a well*

the ring by means of which the tripod can be leveled up. The tube is so supported at its mid-length that it can be swung freely in a vertical plane. Above its point of support, there is clamped to the tube a metal compass-card, or graduated horizontal circle. The amplifier attachment, and the telephone receivers, which will be noted in the hands of Mr. Anderson, are for listening in on the mechanism, and coordinating by stop watch with a time schedule on which "shots" are taken during the lowering of the survey machine into the well. Carried on the base ring of the tripod and provided with set screws for its adjustment, is a graduated vertical arc



GLASS MODEL OF WELL

The horizontal plates represent planes at various depths. The dark line to the left represents a plumb line from the derrick floor. The other line traces the exact path of the well hole through the various geological formations encountered

which is provided with a clamp attachment by which the survey tube can be held in any determined position.

The illustrations show some of the surprising facts which were brought to light by a survey with this machine of the famous Olinda Well Number 96 in Orange County, California. This is the deepest well in the world. At the time that this survey was made, May, 1926, it had reached a total depth of 6,948 feet. At the present writing, it is down to over 8,000 feet.

We present a photograph of a glass model which was built to show the amount of deviation from the vertical at the different levels. The plan of the underground course of the hole proves that, in addition to traveling very much out of plumb, the drill also moved in a general circular or rather rectangular direction. It shows how the course of the well would appear if it were projected onto the surface of the ground above. The survey machine was lowered into the well to a measured depth of 6,522 feet. After each stand of pipe was attached and lowered, the machine automatically made a photographic record; an additional reading was taken at the bottom of the hole, making a total of 75 photographic readings. The survey started at 8:45 A.M. and reached bottom at 3:50 P.M. The following July, when the hole was 1,000 feet deeper, the machine was again lowered to the bottom of the well.

MR. ANDERSON tells us that unexpectedly high temperatures were encountered and that they incapacitated the batteries inside the machine, so that the photographic record ceased at a depth of 6,948 feet. The temperature was determined by laboratory tests made on similar batteries, and it was found to have been about 212 degrees, Fahrenheit. It is believed that with the use of improved insulation inside the machine, the survey can be carried down to 8,000 feet. The first part of the hole, to a depth of 3,751 feet, runs in a general southeasterly direction; then the slope of the hole changes to a northeasterly direction and follows this course down to a measured depth of 5,962 feet. Here, the hole swings sharply around to a direction north 75 degrees west and maintains this course with the last reading at 6,948 feet.

The glass model shows that there is a rather even rate of departure from the vertical from near the top of the well to the 6,000-foot level where the hole is not less than 517 feet off vertical. From that level, it swings back towards the plumb line and is 348 feet off vertical at 6,948 feet depth.

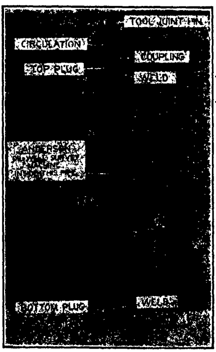
Now, let us see what is the significance of these erratic wanderings of the well hole as revealed by survey. Let us suppose that oil had been struck at the depth of 6,000 feet, where the lateral drift has carried the well to its extreme distance of 517 feet, measured horizontally from the derrick floor. This would mean that under the derrick there would be exactly 30 acres of untapped area.

Mr. Anderson, writing in *Petroleum World*, tells us that there is a good deal of literature dealing with the

TRANSPORTING THE MACHINE

The device is carried long distances from well to well. It rides on a steel frame, designed to protect it from shock

spacing of derricks according to theoretical considerations. Such suggestions show that the great underground drift of wells was not formerly appreciated. Underground surveying of California rotary wells has demonstrated that wells in the same field do not follow parallel lines underground; the amount of drift of two adjoining wells might also vary within wide limits. It is surprising to learn from this authority that Olinda Number 96 is by no means an exceptional case of large drift, since the drift of some shallow wells has been found to exceed that amount. Furthermore, the fact that wells drift in different directions and by different amounts suggests that areas of untapped oil sand may exist under leases that are seemingly fully drilled.



THE SURVEYING MACHINE

This consists of a steel shell 3/16 of an inch thick, three and one half inches in diameter and seven feet long, within which are batteries and an ingenious mechanism for recording photographically the inclinations and positions of the well at various points in its wanderings from the perpendicular. The results obtained are fully described in the text

DETERMINING THE EFFECT OF SUNLIGHT ON PLANT GROWTH
The plants to be tested are placed on small cars and exposed to sunlight for definite periods

Our Agricultural Ellis Island

How the Department of Agriculture is Using a Famous Old Virginia Estate as a Testing Ground for Immigrant Plants

By GEORGE H. DACY

ALMOST under the shadow of the huge radio towers at Arlington, Virginia, and contiguous to the borders of our greatest national cemetery, is located the finest plant proving-ground under the sun—an outdoor laboratory for grain, grass, fruit, flower, crop, bulb and soil research whose fame has reverberated around the world.

Spacious and palatial Arlington Farm, a cradle of American history and a clearing house through which thousands of foreign crops, fruits, nuts, berries and vegetables have gained citizenship in these United States, annually attracts agricultural scientists and visitors from the four quarters of the earth. It is unique and unrivaled in its distinctiveness. There is not another experimental enterprise in all creation that is the equal of this farming estate which nestles close to the banks of the meandering Potomac.

FATE'S shuffle has written a most curious history at Arlington Farm. Once it was the beloved home of the notable Custis family of Virginia, and was widely heralded as a center of lavish hospitality. Later, it was the scene of some of George Washington's surveying exploits. Our first President surveyed and constructed a viaduct under the historical Chesapeake and Ohio Canal which penetrated a part of Arlington Farm and is still in use. Subsequently, General Lafayette and his son visited at the manor house which once stood where the superintendent's home at Arlington is now situated. After the tumultuous times of the Civil War, Arlington—once the scene of brilliant fetes and parties—slumped into discard and was used by the War Department as a mammoth pasturage for army mules. Negro squatters took possession of some of the outlying land, where they built crude cabins.

It was exactly 26 years ago when the War Department transferred the tract of 400 acres to the United States Department of Agriculture to be used as a plant, fruit and crop experimental station. From then to the present day, government experts have been busily engaged in reclaiming the impoverished fields, and in providing essential buildings, laboratories, greenhouses, fertilizer factories, cold storage facilities and other research appliances. Today, Arlington Farm is the official testing ground for the most extensive experimentation in soil tillage, crop production and plant life ever attempted. Uncle Sam spends from 350,000 to 400,000 dollars a year in scientific research at this great establishment. Epochal results have been secured since the inception of the test farm, and these justify its existence forever. The investigations have saved untold millions of dollars annually for American agriculture.

Fully to appreciate Arlington Farm, one must browse through the pages of dog-eared histories and time-stained records. They add the sparkle of romance and the tinge of adventure to a national estate which now is used as a try-out center where old theories, new-fangled ideas and agricultural speculations and surmises are subjected to thorough tests.

Where John Parke Custis once produced corn, cotton and tobacco and where his son, George Washington Parke Custis, later lived and gained fame as a prince of hosts, Uncle Sam, master-farmer, now cultivates rolling fields and level bottomlands.

THE King of England granted a patent to the colony of Virginia to Lord Culpeper and the Earl of Arlington, during the days when knee breeches and silken ruffs were in style. Arlington Estate was christened in honor of the latter celebrity, by a certain Robert Howson who secured a grant to 6000 acres of Northern Virginia land from Sir William Berkeley. Eventually, Howson traded Arlington to General John Alexander for 64 hogsheads of tobacco.

During the latter months of the Revolutionary War, John Parke Custis purchased 1100 acres of Arlington

Estate from General Alexander, paying 1100 pounds in Virginia currency for the property. Mr. Custis was the son of Martha Washington, America's "first lady of the White House." George Washington Parke Custis, the adopted son of General George Washington, in the course of time, became the sole owner of Arlington through inheritance.

The first agricultural fairs and live-stock exhibitions in the United States were celebrated at Arlington Estate during the occupancy of George Washington Parke Custis. He was a pioneer patron of pure-bred stock. He offered prizes and the use of his estate to rival stock- and farmers who assembled their fat, sleek-conditioned horses, cattle, sheep and swine in order that experienced judges might select the annual champions.

STUDYING SOIL BACTERIA

Tiny bacteria annually manufacture 1,000,000 tons of nitrogen which is stored as plant food on the roots of clover, alfalfa, beans and peas

Upon the demise of George Washington Parke Custis, Arlington became the property of his daughter, Mary Ann Randolph Custis, who, in 1831, was married to Cadet Robert E. Lee of the West Point Military Academy.

THE next remarkable events chronicled at Arlington, occurred after the abandonment of the estate by the Lee family, Robert E. Lee moving to Richmond where he became military leader of the Confederacy. Shortly thereafter, Arlington was confiscated by the Federal Government and was used for some time as one of the Union Army headquarters. Three years later, it was sold for tax arrears and was purchased by Uncle Sam for 26,000 dollars. It was not until 1877 that the Lee family finally won a settlement from the Government for its treasured and cherished estate. At that time, the courts awarded 150,000 dollars to George Washington Lee, the chief surviving heir.

The original Arlington Estate is now subdivided into three units, each of outstanding national and historical importance. One tract composes Arlington Cemetery, designated as such by Abraham Lincoln. Another portion now consists of the Fort Meyer (Virginia) Military Reservation where leading detachments of the United States Cavalry are stationed. The third body of land has been improved and perfected as Arlington Farm, where America's most intricate crop-production riddles are solved.

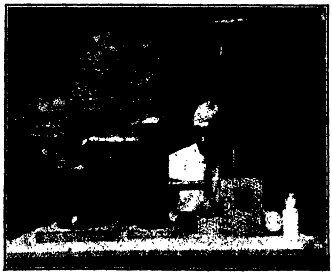
You can appreciate that the plant research at Arlington Farm can be continued to the millenium when you understand that civilized man now uses only about 200 of the more than 500,000 distinct species of plants which have been identified. One of the great works of the Department of Agriculture is to introduce and test out at Arlington Farm as many of the unused plant varieties as are adaptable to American soils and climate. This is a prodigious assignment.

Take the case of soy beans, for example. All the leading species of this billionaire crop now in use in the United States were first tested as plant immigrants at Arlington Farm. Selections were made which have proved to be valuable mortgage-lifters in the different sections of our continent. Today, I than 1,500 additional varieties of soy beans are being studied by science as they grow in Arlington's fertile fields. Translate these figures pertaining to one specialized crop into terms of the several hundred crops which are experimented with, and you can visualize the magnitude of this matchless agricultural project.

EVEN in this day of our 48 state experimental farms, agricultural colleges and thousands of sub-stations with scientific experts working constantly, the food-producing power of the world is still practically unknown. This is because science has only just begun to study, in a modern way, the relative performance of different plants. Arlington Farm is the leader in this campaign to unlock the secrets of plant production which, since the dawn of human existence, have been barred from man's knowledge. To help find the plant which will produce

MODEL OF FERTILIZER FACTORY

ernment experts, when built in making concentrated fertilizer



ELECTRIC PRECIPITATOR AND FURNACE

This is another model of an efficient apparatus of government design that is a result of work at the Arlington Farm

A COMPLETE FERTILIZER FACTORY
One of the full-size manufacturing-plant installations at Arlington Farm

the best food results of any that can be grown on every acre of land in this country, is, in general, the broad policy of the United States Department of Agriculture. A veritable flood of plant life annually flows from all parts of the globe to Washington and eventually is tested under practical field conditions at Arlington.

The finest arterial highways and cross-country boulevards in America trace back to research of one kind or another which has been consummated at Arlington. The Bureau of Public Roads, since its rise to international prominence as a highway investigator, has conducted the majority of its experiments at this research factory. The purpose of many of these tests has been the ultimate development of standardized systems of highway construction—the building of roads which will not only withstand current vehicular traffic but which will resist the wear and tear of the ever-increasing potential burdens and loads.

The influences of freezes and thaws, drainage and drought on permanent roads have been surveyed; viralithic and strength tests of concrete have been made. Subgrade research, the effects of six-wheeled trucks on highways, the impact influences of heavy loads, the use of original machines to simulate heavy traffic on test roads—these and hundreds of other experiments have been performed.

MUCH that we know about soils and fertilizers results from Arlington's practical research. During the last 14 years, experiments in the production of high quality, concentrated fertilizers from low-grade materials have yielded revolutionizing results. In this campaign, the government specialists had to invent new fertilizer factory appliances, including electric blast-furnaces. They perfected miniature fertilizer factories and made the experimental products under commercial conditions. Now they are testing these concentrated fertilizers—the "T. N. T." of the plant food world—in all parts of the country. The potential results will be the annual saving of millions of dollars in fertilizer freight and storage bills. The concentrated fertilizers, which are four to five times as rich in plant food as ordinary commercial fertilizers, can be shipped long distances at comparatively low costs and used to grow three stalks of grain where one half-starved specimen previously was produced.

The fine turf gardens at Arlington are the best which greensward technique ever grew. The United States Golf Association co-operates with the Department of Agriculture in testing out hundreds of different kinds of grasses, fertilizers, greens-keeping methods and insect and disease eradication systems at this northern Virginia station. The creeping and velvet bents—the premier golf-greens grasses of the central, northern and northwestern United States—have been selected and improved. The Government's tests of grass growing annually save millions of dollars to the 2,000 or more golf club courses and public links now in use in this country.

TWO hundred acres of cultivated crops were grown, mostly in diminutive experimental tracts, at Arlington last year. Breeding, disease resistance, fertilizer, soil-inoculation, self-sterility, germination and seed treatment tests of various kinds have been made. Such important commercial bulbs as Easter lilies, narcissus, hyacinths and tulips are being raised under practical field conditions to solve all the commercial problems associated with that economic industry. Several acres of drug and poisonous plants are also produced for scientific purposes. Field and greenhouse studies of root-nodular bacteria which occur on all leguminous plants are in progress. Crop rotation as it influences the development of beneficial and harmful bacteria is also under the microscope of scientific test. The riddles of sugar beets, tobacco, cotton, sugar cane, vegetables, truck crops, grains and hays are being explored and answered accurately from practical investigations under "dirt-farm" conditions.

More than 50,000 introductions of

BLAST FURNACE FOR FERTILIZER EXPERIMENTS
Here is only one of the many large installations made by government experts

foreign plants have been raised under the observant eyes of farming experts. Durum wheat brought in from Russia 18 years ago, tested and popularized by Uncle Sam, now yields 40,000,000 bushels, annually worth 60,000,000 dollars to American farmers. Hairy Peruvian alfalfa imported in similar manner and acclimatized in California, now adds an extra 5,000,000 dollars a year to the farming income of the Golden State. The notable Pima cotton of Arizona, which produces a 20,000,000 dollar annual crop, was introduced from the Nile-fed fields of Egypt via the United States Department of Agriculture.

THE EXPERIMENTAL ROSE GARDEN

This garden at Arlington Farm is run in cooperation with the American Rose Society

AMERICA'S date and fig growing industries came into being through Arlington Farm's assistance. Sudan grass from Africa which made good in Virginia trials, now is an established economic crop in this country. It produces hay and forage worth 15,000,000 dollars every 12 months. Japanese sugar cane, a 4,000,000 dollar crop, Rhodes grass, a million dollar forage, Siberian millet, another millionaire, and *feterita* from the Sudan, which produces 12,000,000 dollars' worth of feed a year, are other plant immigrants which have been naturalized in the United States as a consequence of Arlington's scientific aid.

A rare tree from Molokai, now under test, produces a crop like cotton; a tropical tree from Nigeria yields berries which will even sweeten vinegar; a palm tree from Para which bears a food like a potato; a new fruit tree from West Africa with bunches of edible peach-like fruits; a variety of Job's-tears from Brazil; *spekboom* from South Africa; *huauhtli* from Mexico, a grain raised extensively by the Aztecs which prospers in arid regions too dry for corn; *chayotes* from Central America; the *inga*, a tropical walnut from Guatemala, and the *m'tsama* melon, the chief water supply of travelers in the Kalahari Desert, are other extraordinary plant immigrants now being grown under national observation.

The wonderful discovery that daylight exposure is the most important factor which influences plant growth was made at Arlington, where a multiplicity of plant specimens were maintained in cells as dark as the corridors of Stygia. These plants, in tubs and boxes placed on small cars, were hauled outdoors daily on steel tracks and exposed to sunlight on definite schedules. These experiments revised the world's oldest theories about plant growth, for they proved that daylight was more important than either temperature fluctuations or seasonal cycle in the development of plant life.

TESTING GRASS FOR GOLF GREENS

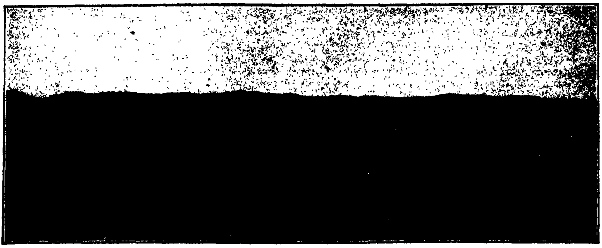
Determining the suitability of grass for greens is an important part of the work

PROBABLY the finest collections of roses and peonies ever grown are raised annually at Arlington in cooperation with the American Rose Society and the American Peony Association. Excellent collections of iris, hardy chrysanthemums and other ornamentals are also produced.

The Government operates a large experimental cold-storage laboratory at Arlington, where the responses of fruits and vegetables to simulated marketing journeys and processes are studied. A circulatory refrigerated brine system penetrates the 16 cold-storage rooms whose combined capacity is eight carloads of foodstuffs. Potatoes, citrus fruits, nuts, perishable vegetables and similar products are stored and studied under a vast variety of conditions.

The national Bureau of Chemistry also maintains an important color laboratory at Arlington where research in the certification of food colors is conducted. Investigations of biological stains and dyestuffs have also been made. The outstanding grain-dust explosion research, which has saved hundreds of lives and many million dollars' worth of property for American industry during recent years, has been carried on at the estate where the Custis family formerly resided. Small models of grain elevators, factories and food-supply plants have been made and blasted to smithereens in the process of these trials.

All in all, Uncle Sam's 26,000 dollar land purchase has proved of inestimable worth to the nation.



INTERIOR OF METEOR CRATER, NEARLY A MILE ACROSS

Here the photographer

The Most Fascinating Spot on Earth

A Comet, Weighing Millions of Tons, Is to Be Sought Where It Lies Buried in Arizona

By D. MOREAU BARRINGER, JR.

MUCH has been written and published about the Meteor Crater of Arizona, but it appears that most people have only a hazy knowledge of the subject at best. This is due, I think, to the fact that the technical publications about it have never had wide circulation; and to the fact that the more popular articles on the subject which have appeared from time to time have often been woefully distorted. It is a subject that seems to challenge the imagination of the average newspaper writer, and several of them have entirely outdone the actual facts in their sensational descriptions of it.

The physical aspects of the Crater are simple. In a flat, treeless plain there is a round hole, surrounded by a raised rim of crushed rock. The hole is about four-fifths of a mile in diameter, and some 450 feet deep, not counting the height of the rim, which rises on an average 120 feet above the plain. This makes the total depth of the hole below the crater's rim about 570 feet.

The geological formations of the region are also simple, being horizontal sedimentary rocks. Except where affected by the impact of the meteorite, they are undisturbed and lie quite level. The surface of the plain is limestone of Permian age, with here and there a few remnants of purple sandstone of the Triassic period remaining on top of it, as little hills. Below the limestone, which is about 250 feet thick, lie a thousand feet of soft, white sandstone, also Permian. The lowest members of this bed have a yellowish or brownish tinge, but the great majority of it is white. Below this lies an indeterminate thickness of hard, red sandstone, quite different in both structure and hardness from the white sandstone above. This is either Permian or upper Carboniferous. For greater lucidity I shall refer to these beds by their local geological names. The remnants of purple sandstone belong to the Moencopie formation; the limestone is the Kaibab limestone; the white sandstone in the Coconino; and the hard, red sandstone below is known as the Supai formation, or more commonly, as the "Red Beds."

Except in the neighborhood of the Crater, these rocks, as I have said, are lying level and undisturbed. Around the edges of the hole, however, they are greatly cracked and broken, and have been raised up so as to slope radially away from the hole in all directions. Those rocks which once occupied the hole itself have been smashed into fragments of all sizes and thrown into the air, from whence some of them fell back into the hole, partly filling it, the remainder being scattered and piled up around the rim.

Mixed with these fragments around the hole and on the plain a short distance from it *there have been found a far greater number of iron meteorites than have been found on all the rest of the earth's surface put together.* And, what is even more striking, the closer you get to the hole the

Science Backs Meteor Crater

Because certain people, reluctant to believe the unprecedented, regard as sensational the theory that Meteor Crater was formed by the impact of a giant meteor which struck the earth, we have obtained the following definite statements from two well-known scientists:

"I am perfectly willing to make a strong affirmative statement in support of Mr. Barringer's article," writes Dr. W. F. Magie of the Palmer Physical Laboratory, Princeton University, "but there ought to be no need for it. There is no reasonable doubt that the Crater was formed by the fall of a meteor and that this meteor is buried in it."

Dr. Elihu Thomson, Director of the Thomson Laboratory of the General Electric Company, writes, "I am very willing to be quoted as follows: 'There can be no question of the Crater being made by masses of meteoric iron, and that an enormous mass of such iron remains buried under the south wall of the Crater.'"

The Editor.

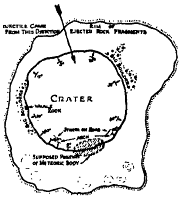
more you find. In other words, the center of the swarm of meteorites and the center of the Crater coincide.

In addition to the solid, metallic iron metorites, there has been found a great quantity of pieces of iron oxide, which by its structure and composition, has been shown to have been derived, by terrestrial oxidation, from meteoric iron. The distribution of these fragments is the same as that of the metallic iron. Both are found intimately admixed with the material excavated from the hole—in other words, *the excavated material and the meteorites got there at the same time.*

THIS is sufficient data on which to advance a proof of the metoric theory of the origin of the Crater. Either the hole was made by a metorite or a cluster of metorites, or else the juxtaposition of the hole and the meteorites is accidental. If accidental, then you have the coincidence of an unprecedented fall of meteorites hitting the same spot on which suddenly appeared an unprecedented crater in sedimentary rocks, and hitting it at the same instant of time in which the crater was made. The chances against such a coincidence are, of course, many billions or trillions to one. Many other proofs of the meteoric theory have been advanced, but this one has always seemed sufficient to me.

It was quite sufficient, also, for my father and the men who were interested with him in the first exploration of the Crater. As soon as they had established not only the coincidence of location of the meteorites and the hole, but also their simultaneity in time, they acquired the property and set to work to find the main mass of the metorite. That was in 1903.

They reasoned (mistakenly, as we now know, for hindsight has a few advantages over foresight) that, since the hole was round, the meteorite must have fallen vertically, and therefore be in the center of the hole. On this assumption they started a shaft at the center of the Crater, from which they expected to run radial drifts, like the spokes of a wheel, when they reached the required depth, until they encountered the mass. They knew that the meteorite had not penetrated



MAP OF METEOR CRATER

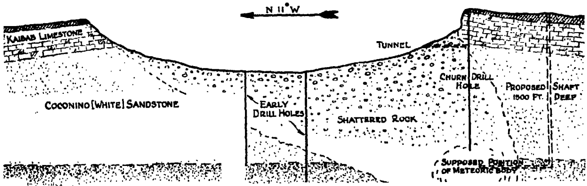
This series of articles will be made much clearer if the reader will study the angle of dip of the strata all around the rim, as indicated by figures on the map. At the north, they are nearly horizontal; on either side they change gradually as the south rim is approached, finally standing on edge; above the buried body they are horizontal again, but this portion was raised bodily 100 feet by the impact, instead of being bent. This part is termed the "arch" by the author

more than 1300 or 1400 feet below the surface of the plain, because no piece of the Red Beds, which lie at this depth, had been thrown out.

But in the shaft at the depth of 200 feet they encountered an unexpected obstacle. A great deal of the soft Coconino sandstone had been so shattered by the impact as to be in the form of fine white dust—so fine that 55 percent of it will pass through a 200-mesh screen. This silica dust became mixed with water in the center of the Crater—for the catchment area of the crater, 4000 feet in diameter, is considerable and collects all the scanty rainfall which falls on it—and had made a quicksand through which they were unable to drive their shaft. Luckily, as we have since discovered, this quicksand is only local and is confined to the central portion.

THE next step was to sink deep drill holes in an effort to locate the mass. Still proceeding on the theory of a vertical fall, they thoroughly explored the central portion of the great bowl to a depth of a thousand feet. This drilling, although it failed of its purpose of finding the mass, did disclose some interesting facts. From the floor of the central portion of the Crater to a depth of some 90 feet, the ground is composed of stratified lacustrine sediments, practically all crushed sandstone and limestone.

From 90 feet down to 600 or 800 feet, the ground is a jumble of large and small fragments of limestone and sandstone, unstratified. This is the material which was thrown into the air at the time of the impact, and immediately fell back into the hole, partly filling it. In this material were found a great number of small specks of oxidized meteoric iron—possibly sparks thrown off by the advancing meteorite. Two very interesting forms of rock were also found in the shaft and in the drill holes, both of them metamorphic products of the white Coconino sandstone. They are known as Variety A and Variety B of the metamorphosed sandstone.



CROSS SECTION OF METEOR CRATER, APPROXIMATELY ALONG A NORTH AND SOUTH LINE

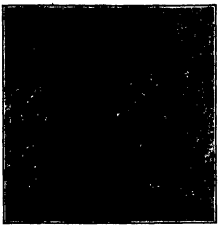
This shows how the meteoric body, thought to be about 500 feet in diameter, smashed its way into the solid rock. The outline of the shattered rock, shown by dashed line, is not accurately known, but the drill holes indicated above, coupled with the knowledge that a paraboloidal hole would be made by the projectile, establish it relatively well

Variety A, (which is also found outside the Crater on the rim) appears, at first glance, almost like the unaltered sandstone. Its structure, jointing, and cross-bedding are quite distinct. But the rock is soft and friable, and a closer examination reveals that nearly every individual sand-grain in it has been so cracked and shattered that it can be rubbed to dust between the fingers or on a piece of glass. One of the workmen aptly termed it "ghost sandstone." The explanation of the phenomenon is not easy, but it would appear that a shock-wave, of sufficient intensity to crack the sand-grains, ran through the solid rock ahead of the impacting meteorite, and ahead of its excavating effect. When the big chunks of sandstone were subsequently broken and thrown out, most of the sand-grains in them were already thoroughly cracked, (like a cracked window-pane that still stay in the jamb) but the structure of the rock itself was practically unchanged. The only major change in the structure was the development of cleavage planes, at various angles to the bedding.

THE second type, or Variety B, of the metamorphosed sandstone, is quite different. Here the metamorphism was due to heat, caused by the friction of the advancing meteorite. This heat was locally so intense as to fuse the silica, and the resulting Variety B is sometimes quite glassy.

Where friction between parts of the meteorite and the rock produced fusion of the latter, one would also expect to find evidence of fusion or volatilization of the former. And this is the case. Here and there, on pieces of the Variety B sandstone, are found yellowish and dark stains of iron oxide, which always give a reaction for nickel. This reaction for nickel, by the way, is used as a conclusive proof of the meteoric origin of the material tested, for all parts of the meteorite carry from 4 to 8 percent of nickel, while no trace of nickel has been discovered in any of the unaffected indigenous rocks.

On the strength of this slight staining by vapors of meteoric iron, it has been suggested by some that the entire mass of the meteorite (some 10,000,000 tons) may have been volatilized by the impact, and so have disappeared. To anyone familiar with the staining powers of iron oxide such a theory is manifestly impossible. Ten million tons of iron, if converted into oxide, could spread a red, insoluble coating, one eighth of an inch thick over more than 300 square miles; or a deposit two feet thick over an area two miles square around the Crater. Instead of any evidence of such staining, we find all the rocks of the region peculiarly white and free from iron, except for the infinitesimal amount of the Variety B which is discolored in the way I have described.



VARIETY B

Appearance of the metamorphosed sandstone, produced by the terrific friction of the meteoric body as it passed through the sandstone

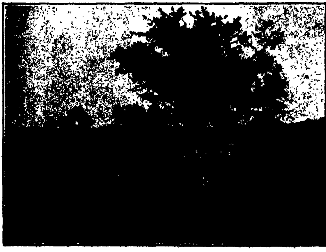
Both Variety A and Variety B of the metamorphosed sandstone present additional proofs of the meteoric theory. The shattered sand-grains of Variety A clearly show the effect of a sudden terrific blow, rather than the effect of any volcanic explosion. The same is true of the millions of tons of "rock flour"—that is, finely pulverized sandstone which forms part of the rim and crater.

But to continue with the drill holes. At depths ranging from 600 to 800 feet, the drills encountered solid sedimentary rock, bedded horizontally, and showing no effects of alteration since the late Paleozoic geologic time when they were laid down in the sea. At a little below 800 feet, the Red Beds sandstone appeared, in place and entirely unaltered. One drill went over 100 feet into this standstone and, of course, found no evidence of alteration there. Seven drill holes sunk in the central portion of the Crater entered the Red Beds sandstone and all showed it to be in place and unaffected by any agency.

HERE were two important pieces of information. Finding the depth of the Red Beds gave pretty accurate information as to the depth at which the meteorite must lie buried, and finding the rocks unaltered below that depth gave additional proof that whatever caused the hole came from above and not from below. No volcanic or steam explosion could have caused all that havoc in the overlying rocks without disturbing the beds beneath.

But although these drill-holes furnished a lot of interesting and useful information, still they failed to disclose the whereabouts of the meteorite. And, furthermore, they used up most of the funds available for the search, so that work was suspended. That was in 1908.

¶ *In the next issue Mr. Barringer will tell how an accidental discovery pointed out the direction of flight of the projectile from space. This discovery virtually locates it.*



CRUSHED AND PULVERIZED SANDSTONE

This is the rock flour, exposed in a stream cut, which is abundantly found in the crater. It is described in the text

THROWN OUT BY THE SUDDEN IMPACT

"Whale Rock," mentioned in the article. Its position is shown on the map, page 53. Note the Mexican's hat in the picture

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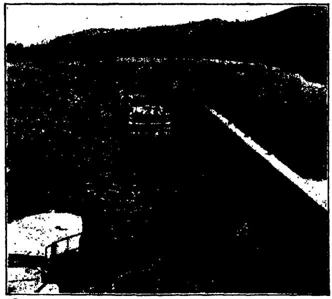
THE OLD AND THE NEW

A lovely stretch of the old Chesapeake and Ohio Canal beside the Potomac. The first surveys were made by George Washington



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VIEW ON STATE BARGE CANAL

Two grain barges on the State Ba leaving Lock Number 9 near the to

Uncle Sam, Spendthrift—XI

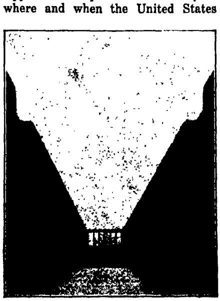
Failure to Develop and Deepen Our Lake and River Systems Causes an Enormous Economic Loss

By J. BERNARD WALKER

MANY an American who has journeyed through Europe with an observant and unprejudiced mind must have noted how extensive are the canal systems of Europe, and what an abundant use is made of the inland navigation facilities thus afforded. He may have memories of a trip up the Rhine, and not the least permanent of all impressions is that of the stream of barges of large size that moved in continuous procession up and down that busy waterway; and the same conditions may be noted all over Europe. The dam and the dredge have done their work; banks have been raised and entirely new connecting canals cut at strategic points. It appears to the traveler that much of the continent of Europe is net-worked with canals that are teeming with traffic.

In returning to America, with these impressions still strong in the traveler's mind, he must have been struck with the magnificent liberality with which Nature, by means of lake, river and stream, has provided immediate or prospective waterway systems. If so, his admiration was tempered with the thought that America, for all her shrewdness, intelligence and activity, has practically failed to make use of the promising transportation facilities thus provided.

Oh yes, we have some canals and we have done some dredging; but the work has been done in a haphazard, desultory way, without any broad-visioned plan or any ordered, continuous work. The vast floods, which at the hour of writing are spreading desolation throughout the Mississippi Valley, are chargeable to the fact that the work done has been "spotty," both as to time and locality. Had the money which has gone into the Mississippi River improvement been spent where and when the United States Engineers Corps directed, the levee protection of the river would today be an accomplished fact, and the mighty flood would be moving quietly within its predetermined and amply-protected channel.



LOCK ON WELLAND CANAL

This canal (30 feet on lock sills) will pass shipping around Niagara Falls

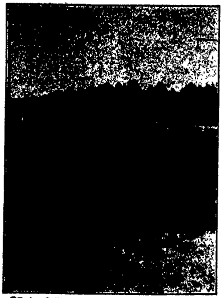
We ask the reader to consider here, and very briefly, some of the magnificent waterway facilities of the United States which need only the hand of the skilled hydraulic engineer, and—in view of the enormous economic conditions to be obtained—a moderate expenditure of capital, to give them rank among the great transportation facilities of the country. First in importance, we place the construction of a shipway from the Great Lakes to the sea; the deepening and control of the Mississippi River; similar work upon the Tennessee, the Arkansas and Rio Grande Rivers; and particularly upon that noble stream, the Columbia River in the northwestern part of this country.

The opening up of a seaway through the St. Lawrence River for ocean-going ships is, of course, intimately tied in with the raising of the lake levels and the deepening of the channels leading to the various great inland ports. The whole question has been most carefully studied by the United States Engineers Corps; the main facts of the situation—considered as an engineering problem—and the practical way to meet them, are

well known and have been clearly explained in various government reports. Enthusiastically back of the proposed seaway is the Secretary of the Department of Commerce, Mr. Hoover, who is himself an engineer of world-wide reputation.

AS regards this Great Lakes-to-the-sea project, the first problem to be solved is the raising of the lakes to a predetermined level and their permanent maintenance at that level. Hitherto, this problem has been in the hands of the politicians, and under their benign guidance, the various states and cities in the lake region are engaged in an unseemly squabble, upon which to date there has been spent a sum of money which would have sufficed to build the simple regulating works which would solve the problem of levels overnight. The United States Engineers' plan calls for the building of certain submerged weirs, notably at the Lake Erie entrance to the Niagara River and at the entrance of Lake Huron to the Detroit River. The Great Lakes provide the finest inland transportation system in the world, but traffic which seeks to pass to the sea must go through "bottle-necks" of 11 and 12-foot canals.

Three deep-sea canals have been proposed. One is from Lake Ontario to the Hudson by way of the new Welland Canal between Lake Ontario and Lake Erie. Another calls for developing a so-called "all-American route" which, in addition to the Lake Ontario-Hudson project, would build a new ship canal in American territory along the south side of Niagara, a costly work which, in fact, would be a duplicate of the Welland Canal. The third—and to our thinking the most sensible and unquestionably the cheapest route—would be to deepen the



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A LOCK ON CHAMPLAIN CANAL

The Lake Champlain Canal is one of the important tributaries of the New York State Barge Canal

St. Lawrence River by means of dams—this last to be a joint undertaking of the United States and Canada.

As regards the St. Lawrence route, the locks of the Welland Canal have been built with a depth of 30 feet to enable the canal ultimately to carry that depth throughout. If an immediate depth of 25 feet is adopted, it will permit the passage of 88 percent of all ships that now enter American ports, and its estimated capacity is 30,000,000 tons per annum.

The report of the United States Engineers of December 6, 1926, estimated the cost of the Lake Ontario-Hudson route at 506,000,000 dollars; of the all-American route at 631,000,000 dollars—and neither of these routes will offer any returns by the development of water power. The net cost to the United States and Canadian Governments of the St. Lawrence route is estimated by the joint engineers of the two governments as between 123,000,000 dollars and 148,000,000 dollars. As regards the hydro-electric power which would be derived from the great rapids which now obstruct river navigation, the commission estimates that the complete practical power development of the river will reach a total of about 5,000,000 installed horsepower.

Now, the opening up of the ports of the Great Lakes to direct ocean-going traffic between them and ports of the world is a matter of huge economic interest to the 18 states which represent that portion of the country adjacent to the lakes and which would be served by such a Great Lakes system. A sufficient answer to the question "why are these states of the mid-west so enthusiastically in favor of building the St. Lawrence Canal?" is to say that this improvement will decrease the costs of the export of grain by seven to eight cents a bushel. Not only will this decreased charge lower the cost to the farmer of reaching his foreign market, but it will be a definite addition to the farmer's profit. Furthermore, it will make possible the introduction of the manufacturers' raw materials to the interior states on a much cheaper basis.

AS the matter now stands, all foreign shipments of agricultural produce have to be taken to the nearest port on the seaboard, either directly by rail, or by combined rail and lake shipping, with a second transfer from lake to rail for the journey to the seaboard.

In this connection, we invite attention to the accompanying map, showing the position of the eighteen states and their cities with reference to Lake ports and to Atlantic and Gulf ports.

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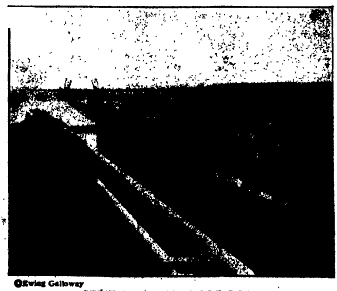
A 2000-TON STEEL BARGE

Twin Ports, a Diesel-engined steel barge, running by way of Great Lakes Barge Canal from Duluth to New York



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VIEW OF FAMOUS SOO LOCKS

Soo locks at the entrance of Lake Superior to the St. Claire River, shown with a typical iron-ore steamer in transit

When the St. Lawrence Ship Canal has been built, the various lake ports will be able to load, let us say grain, direct for Europe as is now done at the ports on the seaboard. The greatly improved position of the shipper as regards the cost of rail transportation is shown by a study of the figures in the various circles. These represent, in the upper half of the circles, the rates in cents per 100 pounds from those points to Chicago, Toledo and Cleveland, and in the lower half the present rate in cents per 100 pounds by rail to the Gulf and Atlantic ports. This map surely vindicates the widespread enthusiasm with which the midwestern states are working to secure the construction of the St. Lawrence waterway.

THE great basin of the Mississippi presents ideal conditions for water-borne traffic. Mr. Hoover tells us that here we have a drainage "upon which for moderate cost we can provide a modern transportation system of 9,000 miles of connected waterways, serving 20 states and furnishing a complete north-and-south trunkline from Duluth through Chicago to the Gulf of Mexico, and an east-and-west system from Pittsburgh to Kansas City." Would it pay? Most certainly. The stretch of the improved Mississippi from St. Louis to New Orleans has proved that modernized, water-borne service can successfully reduce the costs of transportation of commodities in bulk to pre-war rates. Similarly, on a proportionate scale, the development of the Tennessee and Cumberland Rivers would not only provide about 3,000,000 hydro-electric horsepower, but the cities of Nashville and Chattanooga would be afforded adequate water transportation. Similar benefits would follow upon the control and development of the Arkansas River.

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LAKE PONTCHERTRAIN CANAL

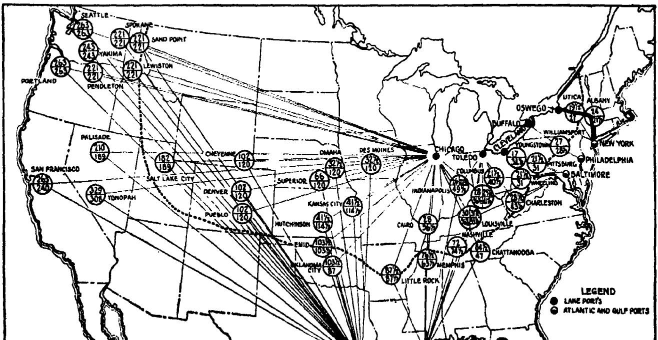
Bridge over the new navigation canal connecting the Mississippi River with Lake Pontchertrain. This fine waterway provides New Orleans with a large, sheltered anchorage basin

Of what could be done on the Rio Grande we have spoken in the previous chapter of this series. Furthermore, in any great national program, such as we now advocate, the great Columbia River should hold a foremost place. In this river, 3,500,000 horsepower await development, and through the basin there is flowing sufficient water for the cultivation of 1,800,000 acres of rich soil, to say nothing of other minor but still important projects. The putting through of this work will also provide that region with a great extension of the present rather limited water-borne traffic.

The Columbia Basin project has been made the subject of three surveys by a commission of engineers of the State of Oregon; by General George W. Goethals; and by a board of engineers of the United States Reclamation Bureau. All have pronounced in its favor.

IF the present rate of growth of population continues, there will be added, during the next quarter of a century, some 40 million people to our population. To provide for the needs of the future, as thus vastly increased, we must either build more railway trunkline systems or we must carry out the waterway improvements mentioned above, so they may take their share of the burden. To build new railways of the capacity of the proposed new waterways would mean the expenditure of three times as much capital.

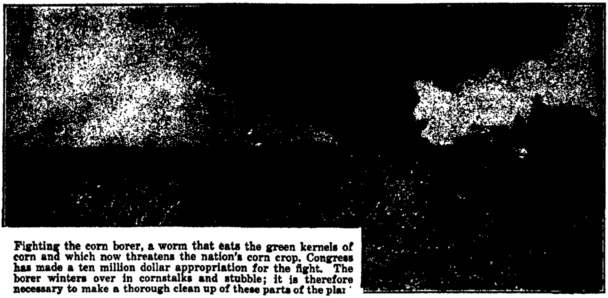
¶ *Growing oysters on trees! This is not a joke, but is a method of increasing the crop of bivalves. This method will be described in a future issue of this magazine.*



MAP SHOWING TERRITORY HAVING LOWER RAIL RATES TO LAKE PORTS

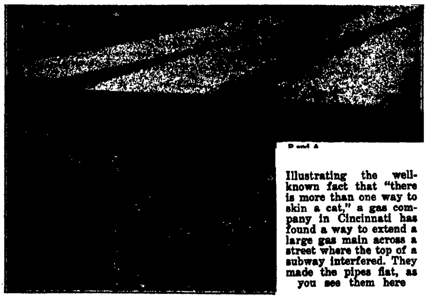
...t will be benefited by making deep-sea ports out of Great Lake ports is indicated by the heavy dotted lin... e first-class domestic [illegible] cents per 100 pounds; upper figures rates to Lake ports, lower to seaboa...

From the Scrap-book of Science—



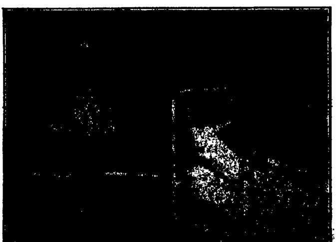
Fighting the corn borer, a worm that eats the green kernels of corn and which now threatens the nation's corn crop, Congress has made a ten million dollar appropriation for the fight. The borer winters over in cornstalks and stubble; it is therefore necessary to make a thorough clean up of these parts of the plant

Father Gherzi, S. J., at the Jesuit Observatory in Shanghai, China, with the Wiecher astatic seismograph. The Jesuits incline rather strongly to science, especially earthquake science



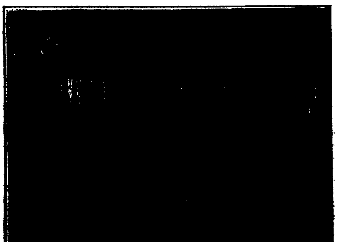
P and A

Illustrating the well-known fact that "there is more than one way to skin a cat," a gas company in Cincinnati has found a way to extend a large gas main across a street where the top of a subway interfered. They made the pipes flat, as you see them here



Wide World

A room has been installed in the University of Pennsylvania Hospital, Philadelphia, for the study of bronchial asthma, allergic colds and hay fever. To exclude all undesired impurities, the air is washed. Substances suspected of causing the trouble, especially house dusts, are then introduced into the room



Harris and Ewing

Apparatus which is being used by Mr. Carl Rosby, Swedish scientist working at the United States Weather Bureau, for making model experiments of atmospheric movements by means of liquids of different densities. In Scandinavia the theory under which this apparatus works is being used for weather prediction

Camera Shots of Scientific Events

P and A

Virtually a submersible cruiser is this new, giant British submarine of 3600 tons displacement. It carries four 5.2 inch guns, can make 22 knots (25.3 land miles) per hour when not submerged, and carries a crew of 120 men. It has sufficient speed to overtake and capture merchant vessels of more than ordinary speed

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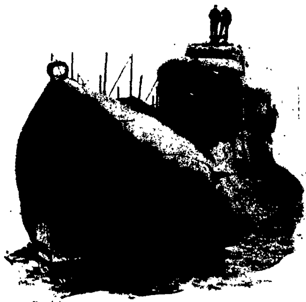
plane engine ... one quarter inch bore and three and one half inch stroke, making 3800 rev-olutions per minute. The wide angle between the cylinders permits better ventilation

P and A



P and A

The forward end of the same submarine, the XI, shown at the top of the page. Her bulbous raised bow is for buoyancy when running on the surface; thus when running into head seas she will rise over the waves instead of cutting through them

Courtesy Timken Roller Bearing Company

The largest Timken tapered roller bearing ever built. Its bore is 42 inches. At 30 revolutions per minute, it carries 2,750,000 pounds. It weighs over two tons

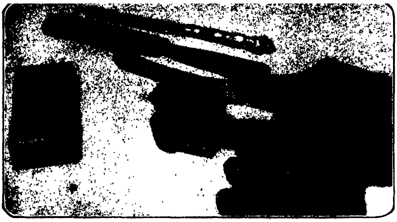
Wide World

Insects that live on books will find life not worth living when library books are made of a new kind of "bug-proof" paper invented by William R. Reinicke, Librarian of the Apprentices' Library in Philadelphia. Mr. Reinicke is showing samples of the work of "bookworms"

Household Inventions

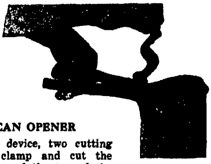
Devices Illustrated on These Pages Make Housework Easier

CONDUCTED BY ALBERT A. HOPKINS



KNIFE POLISHERS

The devices *to the left* and *in the center* have felt strips, between which the knife blades are drawn for polishing. The one in the background is to be used for polishing raised surfaces on handles and the like



CAN OPENER

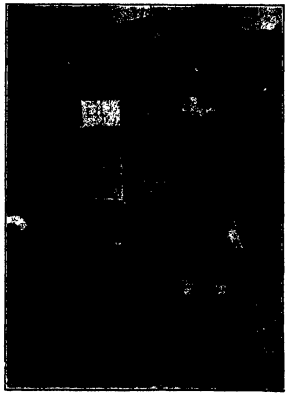
In this device, two cutting rollers clamp and cut the bead around the top of the can and bend the edge under, preventing the possibility of injury to the user

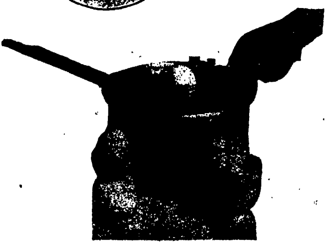
COFFEE STRAINER

The handy wire utensil at the *left*, for use in the kitchen, is fitted with a small piece of muslin or gauze for straining coffee, tea or other liquids. The filtering material can be changed quickly

FIRE LIGHTER

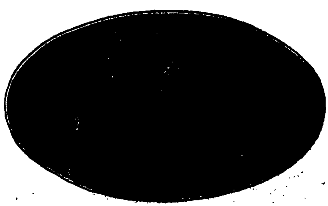
The enormous matches at the right are really matches in every sense of the word. They are to be struck on the box and used for lighting fires. Because of their large size, they are long burning.





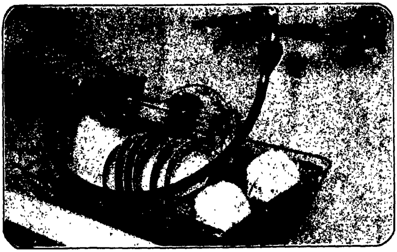
EGG LIFTER

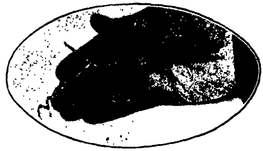
This is the same device illustrated in the left center of this page. Here no cloth is used, as the implement is being employed to remove eggs from hot water. It has many other uses in the kitchen as well as those shown



POURING LADLE

The shape of this large spoon makes it possible to guide fruit, liquids, et cetera, directly into the mouth of a vessel, eliminating spilling



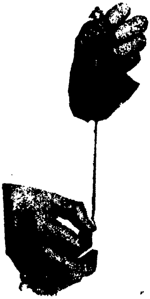


BOTTLE OPENER

Thi ation corkscrew and crown-cap ren.. -- .]ngland. It is separable, the handle of the corkscrew being removable from the corkscrew shaft

DISH WASHER

Small pieces of soap are put in the glass container, the hose is attached to the hot-water faucet, and the soapy stream directed on the dishes

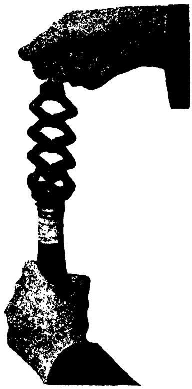


TAPE MEASURE

The imitation clock is a spool that holds a rolled-up tape measure. The hands revolve as the tape is pulled out, registering the number of inches that the tape extends from the holder

KITCHENETTE

This complete kitchen can be installed in a space five feet, six and one half inches long. Every possible convenience for cooking is included here



CORK PULLER

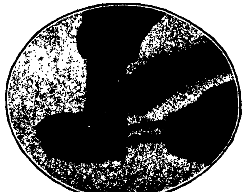
The French novelty illustrated above will remove corks from bottles, even when fitted tightly. The "lazy-tongs" arrangement allows the exertion of a large force directly upward from the bottle mouth, thus extracting the cork without trouble

CLOTHES CLEANER

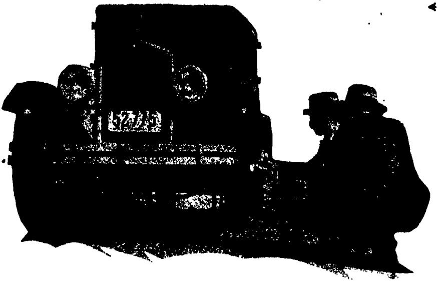
The receptacle above the brush in the device at the left holds gasoline, naphtha, or similar cleaning fluid, which is applied to the clothes as they are being brushed thoroughly

SPOON POLISHER

A soft cloth or piece of chamois covers the end of the device illustrated at the right. It is intended for use in polishing the bowls of spoons as shown



With the Automotive Inventors



AID TO PARKING

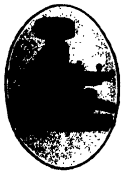
The problem of finding parking space in large cities is becoming one that demands serious thought. If the amount of space required for each vehicle while standing at the curb can be reduced, the result will be that more of them can be parked in a single block. This is what the device illustrated at the left purports to do. A set of four small rubber-tired wheels are mounted on extensible carriages in the under part of the chassis. These are worked through a special gearing arrangement connected to the regular transmission, and when actuated, the regular wheels of the car are raised off the ground. Power may then be applied to the four small wheels, and the entire car moved either to the right or left as desired, thus enabling the driver to park in a small space

ROADSTER-TRUCK

For the purpose of converting a light roadster to a small truck, the body illustrated at the left and right has been designed. This consists of a steel box arranged to run on a channel-steel frame. The rear end of the box replaces the regular body-end. When the car is to be used as a truck, the box may be pulled out and locked in any position

FRONT-END DRIVE

A novel front-end drive for all types of automobiles has been devised by a New York inventor. Because of the spring suspension, and the fact that the axle swings with the front wheels when steering, the vehicle can be turned in a very small circle. The front of the chassis is suspended by only one point; the resulting three-point suspension gives stability

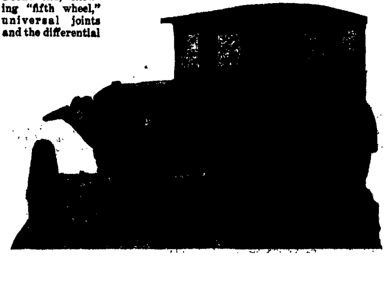


THE MECHANISM

Front end, showing "fifth wheel," universal joints and the differential

ROUNDING A CURVE

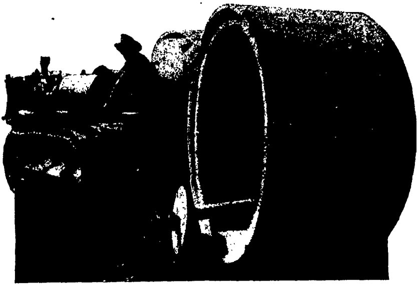
The photograph reproduced below shows the front-wheel-drive car with the wheels turned for executing a sharp curve. With this automobile, it is said that there is less road vibration transmitted to the steering wheel. This is due to the spring suspension, which consists of one half-elliptic and two quarter-elliptic springs. The car will over-ride obstructions with a minimum of twisting of the chassis because of the suspension method used

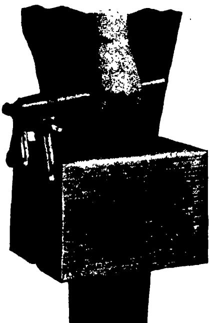


Inventions in the Engineering Field

MOVING LARGE PIPES

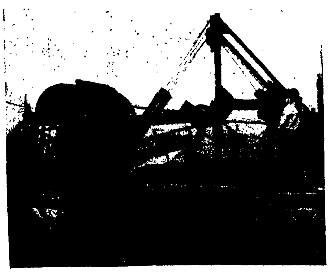
The problem of moving seven-ton sections of sewer pipe proved to be a large one to the engineers of the Western Concrete Pipe Company, until the idea illustrated at the right was hit upon. A length of comparatively small iron pipe was inserted through the concrete pipe, a disk was placed at each end and chains were used to attach the iron pipe to a tractor. When the machine was started. the iron pipe engaged the inner surface of the concrete pipe and the latter rolled along after the tractor. The disks at the ends of the iron pipe supported it

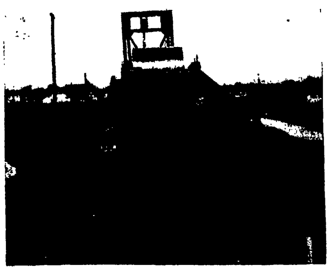




PIPE CARRIER

In the present day scheme of building, concrete and tile pipes and blocks play a large part. When loose and being handled on tl job, their fragility and awkw. 'd shapes are great drawbacks. T eliminate this, the adjustable d(ice illustrated at the left and right has been invented. This is a simple carrier that can be changed in size so as to accommodate either square or cylindrical shapes. A handle is provided, and it is so placed that the workman's hand can grasp i 'ust over the center of gravity, thus making the load balance easily and eliminating t possibility of the pipes slipping off the carrier. As clearly shown at the right, t arms that slip within the pipes or blocks are held in place by bolts and nuts and ›, once set, the carrier can be used on the same size pipe throughout the job





DITCH AND POST-HOLE DIGGER

A ditching machine that digs either straight ditches or vertical holes for locating pipe joints or doing other service work has recently appeared on the market. The photograph above shows the machine in operation digging a square vertical hole. Because of its construction, it can be operated close up against the curb

The ditch digger is shown in operation in the above illustration. The caterpillar bands transmit the motive power, and a discharge for the dirt is placed so that the material is piled to one side. An ingenious construction of the digging buckets makes it impossible for them to be damaged by encountering obstructions

The Scientific American Digest

A Review of the Newest Developments in Science, Industry and Engineering

CONDUCTED BY ALBERT G. INGALLS

The "Paragon" 400-horsepower thermo-electric freight locomotive

A British Diesel-Electric Locomotive

THOSE who have followed with interest the comparatively recent developments leading to the use on some of our railroads of Diesel-electric locomotives, chiefly for switching purposes, will find further interest in the following description of a British locomotive of that variety, sent us by Mr. F. C. Livingstone, of London:

"One of the most difficult problems associated with the development of railway electrification on a large scale, is that of providing an electric locomotive suitable for main-line railways equipped with either a direct or alternating current supply. With this objective in view, a vast amount of experimental and technical research work has been carried out during recent years in America and in Europe. What is known as the 'Paragon' thermo-electric freight locomotive can be used with either steam, gasoline or oil as prime movers.

"Each axle of this locomotive is driven by a special 85 brake-horsepower, direct-current electric traction motor, through the medium of a worm drive. This worm reduction gear is claimed to be the strongest mechanical reducing power, while it also permits the motor to be placed longitudinally with the main frame.

"The generating plant is carried on the locomotive and consists of a 400 horsepower, six-cylinder, two-stroke, heavy-oil engine running at 500 revolutions per minute. This engine is of special design for locomotive work and is fitted with an altitude compensating device, which permits the locomotive to give full tractive effort even at an altitude of 15,000 feet above sea level, where the ordinary types of internal-combustion locomotives fail to deliver their sea-level power owing to lack of atmosphere pressure. Current is generated by means of an electric-kinetic transformer driven by the oil engine. The armatures of the transformer form the necessary flywheel effect for the engine. The weight and cost are reduced by the absence of the common flywheel, which is provided for by heavy roller bearings fitted at each driving end of the engine to carry the armature.

"The starting power is provided for by running the electric transformer as a powerful electric starting motor. The current, which is needed only for a few seconds, is provided by a small storage battery, which is automatically charged from the primary side of the transformer when the main engines are running. This storage battery also supplies the power for the lighting and other auxiliary power work.

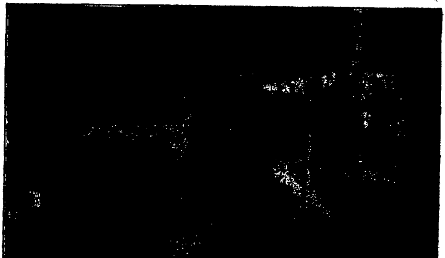
"The locomotive is fitted with two coolers, one at either end. These draw the air in at the center and, by means of a variable speed, electrically-driven turbine-type fan, the heated air is thrown out radially, thus preventing road dust from being blown into the machinery in the locomotive cab. The coolers are of strong construction and are fitted with copper tubes, the whole being tested to 120 pounds per square inch working pressure.

"The locomotive, which weighs 43 tons when in full working order, has a starting tractive effort of 10,000 pounds and a maximum speed of 26 miles per hour. The length of the locomotive over all is 33 feet, six inches."

Effective

A CONSIDERABLE portion of the Maine blueberry crop was saved from destruction last season by a process invented and patented by B. J. Howard and C. H. Stephenson of the Bureau of Chemistry, United States Department of Agriculture. The use of this process prevented great losses to the growers of Maine blueberries and made it possible for consumers everywhere to obtain the usual quantity of the delectable blueberry pie. The patent, which has been dedicated to the people of the United States so the process may be used without the payment of any royalties to the inventors, covers a process for effectively removing maggots, debris and unfit berries.

Only clean, sound berries free from maggots may be canned and sold within the jurisdiction of the Federal food and drugs act. The blueberry maggot develops from the egg of a little dark fly,



With this machine, the Maine crop of blueberries, badly infested with maggots, was saved. The machine sorts out the maggots and all of the defective berries at a rapid rate

somewhat smaller than the common house fly. When it was learned that a portion of the crop of blueberries was infested with maggots, it seemed for a time that a large part of the crop might be a loss, since there had been no practical method available for separating the unfit from the sound berries. Messrs. Howard and Stephenson, who had been detailed during recent seasons to study the problem, developed the effective process which has been patented. This process was used with great success during the last canning season by nearly all the canners in the areas where there were infested berries. By separating out the maggoty and otherwise unfit berries, the bulk of the blueberry crop which was sound was saved and rendered suitable for canning. The patented process is not only effective but also comparatively cheap.

The object of the invention is to remove maggots, maggot-eaten and otherwise defective blueberries through the controlled action of water and the mechanical crushing or grinding of the blueberries on each other. This is based upon the fact that blueberries containing maggots or that may be partially decayed are generally more easily broken open than the uninfested and sound berries, and the broken or crushed berries are removed in the process. The berries are revolved in hollow cylinders covered with suitable screen so constructed as to revolve freely, partially submerged in tanks of water, the level of water being maintained automatically at any desired point. An adjustable overflow discharge pipe which drains from the bottom of the water tanks, secures a constant level for the water and also an effective means for removing continuously the objectionable berry debris which tends to settle to the bottom.

One machine will treat effectively 350 to 500 bushels of berries in a day. The amount varies greatly according to the condition of the fruit. It is the general opinion of the canning trade that as a result of the use of this process during the last canning season, a considerable portion of the blueberry crop was saved from total loss.

Courtesy *Illustrated London News*

Right: A scale model of the revolving house, which was displayed at a home-building exhibition in France. This house, and the reasons for its features, are described in the text below

One million dollars worth of blueberries are canned in Maine in some seasons. In one county of Maine, the blueberry crop is the chief source of income of a considerable portion of the people.

French Architect Designs Revolving House

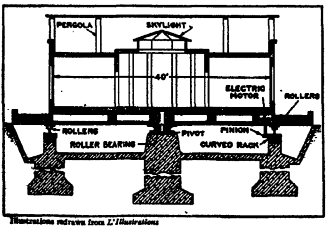
A DWELLING house mounted on a turntable so that any of its eight sides may be quickly swung to face the sun or the summer breeze, is the solution of one common difficulty in the design of homes that has been worked out by two French architects, Georges Lecuyer and Henry Jubault. This dwelling, described in a recent issue of *L'Illustration* (Paris), is not a mere "stunt" but is a practical home of seven rooms, with bath. It is octagonal in shape. By means of an electric motor of four horsepower, it may as easily be swung around as a locomotive is revolved on a turntable.

Tournesol, or "sunflower," is the fitting French name given to this odd dwelling, which, *L'Illustration* states, "was designed in an hour of revery." Completed, it has recently been shown at the exhibition of habitation and decorative arts—evidently a sort of "Own Your Own Home" show—at Nice. With a diameter of about 40 feet, the sunflower house is no toy; it is a real house, although the French journal from which we abstract its description calls it "a veritable plaything of the multi-millionaire." Completely furnished, it cost about 250,000 francs—a "before the war" price of about 50,000 dollars.

The whole house, built of steel and concrete, is carried on eight steel girders which radiate from a central pivot. Each girder rests, at its outer end, on a wheel rolling on the track of the turntable. Near the circular track is a curved rack. A pinion driven by the electric motor runs on this rack, rotating the house. One presses a button inside the house; the house begins turning. Another pressure; it stops. The four-horsepower motor will give it one complete turn in an hour.

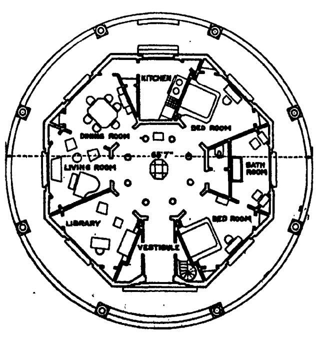
At the center, the house pivots on a vertical pin equipped with roller bearings. The other details are quite clearly indicated in the illustrations.

"GASOLINE to be obtained direct from coal;" "A new process for 'liquefying' coal;" "German chemist discovers way to turn coal into gasoline"—these are some of the interesting newspaper headlines all of us read last fall and winter. We wondered how much of it was true. Fortunately, it was nearly all true, and scientists as well as industrial engineers believe a new industrial era is impending because of these recent discoveries. Not all sensational reports about science are to be scouted. In fact, most really great scientific and industrial advances have been sensational, (but not all sensational announcements are scientific!).



Illustrations redrawn from *L'Illustration*

Above: A sectional plan of the French revolving house. Here are shown the positions of the electric motor, the driving shaft, the pinion and the curved rack. Note the supporting rollers and bearings

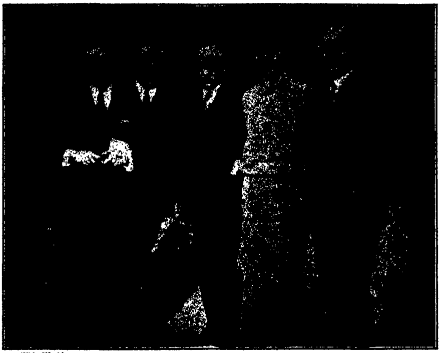


Right: This plan view of the revolving house shows the location and shape of all of the rooms. Notice the completeness of the equipment and the accessibility of all the rooms from the central, circular "hall"

Today there is a great hum in the scientific-industrial world, a hum which is likely to reach the public in larger volume within a few years, when the facts have trickled down from the "inner circles" of the experts to the rest of the world. Coal is the source of the hum. We have been merely burning our coal. Now, it becomes evident, burning coal is a wasteful, backward and altogether shortsighted way to treat it. Coal contains just exactly the chemical elements—carbon, oxygen, hydrogen and nitrogen—needed to make no end of other products which the world greatly needs. The trick is, first, to unscramble these four elements from coal; second, to recombine them in the proper proportions. This is what chemists are now beginning to do and it is why we dare state our belief that a new industrial era impends.

The occasion for most of the newspaper comment on "liquifying coal into gasoline," was the so-called and already famous "Pittsburgh Conference," held last November. This brought together from the whole world 1700 of the world's most capable fuel experts. The exact name of the conference was "The International Conference on Bituminous Coal." Here the great and interesting projects centering about the modern manipulation of the elements contained in coal were discussed for four full days. The Conference, it is already seen, was pivotal in the sense that it brought to a head a number of extremely important fuel developments.

Scientist after scientist delivered descriptions of new processes for performing modern miracles with coal, and the occasion for this note, several months after the event, is that the full report of the Conference, a book of 800 pages embodying each speaker's exact words, has at last been published by the Carnegie Institute of Technology, at which the Conference was held. This report actually forms a technical treatise on practically all the newer strides in the chemist's discoveries with regard to coal, and if the mail inquiries we have received since the subject appeared in the newspapers is any gage of their desires, we are certain that many of our readers will wish to obtain it. In effect, by reading this notable work, the reader may attend the Conference, for the papers are published just as they were there presented.



Wide World

Prominent scientists at the Pittsburgh Conference on coal. Left to right: Dr. Oshima, Director Imperial Fuel Research Institute, Japan; Dr. A. C. Fieldner, Chief Chemist United States Bureau of Mines; John Hays Hammond, famous mining expert; Frau Bergius and Dr. Frederich Bergius, inventor of the famous "berginisation" or "liquification" process for coal

The following comment on the processes revealed at the Conference was prepared by Dr. E. E. Slosson, Director of *Science Service*.

"In the old days before the war, men did not know anything better to do with coal than to burn it. Now they are beginning to find out that it may be put to better purposes as raw material for making more valuable commodities.

"In those days, too, when men wanted to get more gasoline than petroleum contained in crude oil they knew no other way to get it than to smash up the big molecules into little ones; to break down the heavy oils to make light oils. This 'cracking' process was regarded as a great achievement in its day and brought fame and fortune to its inventor; quite rightly, since we could be running few automobiles without it. But the world is passing into another era now, the age of synthesis, when the chemist will build up instead of breaking down. Starting with the commonest and cheapest materials, air, water and coal, the chemist can construct at will all sorts of valuable compounds for which we formerly had to rely upon Nature.

"The veteran French chemist, Prof. Paul Sabatier of Toulouse, opened the door to this new era with the key called 'catalysis.' Shortly before the last century closed, he found that hydrogen gas could be made to unite with carbon-monoxide gas in the presence of finely divided nickel, and produce methane, well known as natural gas. Now these two constituents, hydrogen and carbon monoxide, are easily made by passing steam over red-hot coal—the 'water gas' process. Many other metals and compounds have since been found to act like nickel as a catalyst; that is, they speed up a process by their presence without being used up or appearing among the products.

"This principle has of late been applied with remarkable results by a countryman of Sabatier, General Georges Patart, and still more extensively in Germany by Prof. Franz Fischer, director of the Institute of Coal Research at Muelheim-Ruhr, and Dr. Friedrich Bergius of Heidelberg. All these three European leaders in catalytic research came to Pittsburgh to attend the International Conference on Bituminous Coal, held at the Carnegie Institute of Technology in November, and what they told of the application of catalysis to industry was a surprise to many of our people, for in this field America is far behind Germany and France.

"For instance, we have been making methanol by the old-fashioned method of distilling wood, but now the Badische Chemical Company makes ten to twenty tons of it a day from water gas at a cost of only 20 cents a gallon. Methanol, formerly known as 'wood alcohol,' has long been employed in all countries as a denaturant for industrial alcohol, and has caused many cases of blindness in Germany and America by being used for whisky by those who were already so blind as not to be able to tell one alcohol from another. Various other alcohols, such as butyl alcohol, made in America by fermenting corn and used for automobile lacquers, are made in Germany from water gas. The waste gases that in some sections of the United States are still allowed to escape unused from coke ovens are, at the mines of Bethune, France, cooled and condensed and utilized for making methane, benzene, ethyl alcohol and ammonia.

"Owing to the catalytic process for synthetic ammonia invented by Fritz Haber, Germany is now exporting fertilizer instead of importing it as before the war. About 425,000 tons of free nitrogen from the air is now fixed for fertilizers by catalysis every year, and this takes the place of 2,700,000 tons of Chilean nitrate. But Muscle Shoals still stands idle.

"Benzene, which can be made from coal in various ways, is the mother substance of the aromatic family of chemical compounds, a family of over a hundred thousand and rapidly growing. Among these are the aniline dyes and drugs that have made the world brighter and safer in our generation. One of these synthetic products, carbolic acid, is familiarly used as an antiseptic and is nearly as useful but much less familiar as one of the two components of bakelite. The other component of bakelite, formaldehyde, is also an antiseptic and also is made artificially.

"The chief stimulus to such investigations in Europe is the search for home-made motor fuel. We Americans are not interested in this question now but some day we shall be, and meantime it is interesting to watch the chemists over

the water trying to see how many different things they can make out of common coal, like children playing with the Chinese tangram.

"A motorized Europe, in spite of the scarcity of oil wells and the consequent high price of 'gas' on that continent, is thus held out as a possibility as the result of researches on processes for making a practicable motor fuel out of soft coal, which have been going on for nearly a quarter of a century in Germany and France. Prof. Franz Fischer, director of the Institute of Coal Research, Muelheim-Ruhr, Germany, a leader in the search for a practicable synthetic motor fuel, spoke before the meeting of the International Conference on Bituminous Coal, telling of the petroleum-like products he has been able to obtain by subjecting water-gas to pressure and moderate temperature, in the presence of finely divided iron or cobalt.

"Prof. Fisher uses as raw material the same mixture of hydrogen and carbon monoxide familiar in this country as a part of most city gas, under the name of 'water-gas.' This is made by passing steam over glowing coke. The gas mixture thus produced has high fuel-value but cannot be reduced to liquid form except at extremely low temperatures. How to build these small molecules into larger ones, which would be liquid instead of a gas at ordinary temperatures, and still be useful as an engine fuel, was the problem confronting the investigator.

"He solved it by the use of what the chemist calls catalyzers, that is, substances which, in some manner as yet not understood, speed up chemical reactions without themselves entering into the compounds which they call into being. In this case Prof. Fischer used finely divided cobalt and iron; an earlier investigator, he said, had used the allied metal nickel. With these chemical middlemen present, and using moderately high pressures and some heat, he has obtained three different classes of compounds.

"The first of these, 'synthol,' is a mixture of about a score of inflammable compounds, including a number of the higher alcohols, ketones and esters, as well as organic acids and aldehydes. This has considerable value as a fuel. By varying the process, he has been able to obtain a second product, methanol, which is pure synthetic wood alcohol. Other investigators also have obtained methanol; but although it is highly useful in the arts and industries, it has less value as a fuel than the petroleum-like products. A third product, 'gasol,' most recently obtained, is of the nature of an artificial benzine, which again has high fuel value.

"These researches have been carried out on a technical scale, and it has been proved possible to obtain motor fuel from soft coal in commercial quantities, without troublesome by-products for which to find markets. But as yet the process is too costly to compete with imported petroleum fuels. As the latter become scarcer and more expensive, and the technique of fuel synthesis from coal becomes more refined, it is expected that practical manufacture may be undertaken.

"Gasoline, the most valuable of motor fuels, may be made directly from lignite, the cheapest of coals, by a direct and economical process. The inventor of this process for synthetic petroleum, Dr. Bergius, gave details of the manufacture on a commercial scale of light and heavy fuel oils, lubricating oil, benzene and phenol compounds and ammonia from waste coal dust or low-grade coal.

"That the process has passed beyond the experimental stage and is thought likely to become an important factor in the world-wide struggle for new sources of motor fuel is proved by the fact that it has been taken up by strong organizations in Germany, England and in other countries. An international company has been formed to carry on the liquefaction of coal and in this the largest stockholders are the Royal Dutch Shell group, which is the leading petroleum combine of Europe, and the German association of dye manufacturers. The British government is also interested in this method of making artificial oil fuel and a plant for the purpose of investigating the Bergius process has been erected in England. Two experimental plants are maintained in south Germany, employing 150 men.

"The discovery of how to convert coal into liquid products is not a lucky accident but the achievement of long and laborious scientific research, such as gave Germany the supremacy in the manufacture of indigo and other synthetic dyes before the war. Dr. Bergius began his study of the composition of coal in 1912 and, except for the interruption of the war, the investigation has been carried on continuously ever since at a cost of millions of dollars.

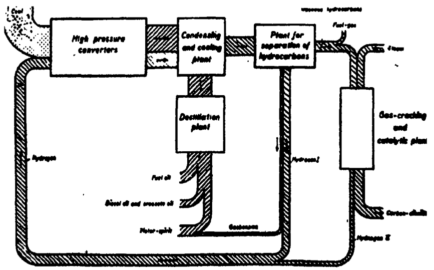
"The essential principle of the process consists in combining hydrogen gas with coal by means of high heat and pressure. The coal is first ground into small pieces less than a tenth of an inch in diameter, and then mixed with heavy oil to a thick pasty mass. This is placed in a light steel retort and heated to about 800 degrees, Fahrenheit, under a pressure of about 3000 pounds per square inch. Most of the carbon unites with the hydrogen, giving a complex mixture of gaseous, liquid and solid compounds similar to those coming from natural wells. In the case of lignite, a low-grade brown coal, as much as 90 percent of the carbon is transformed into such marketable products. The nitrogen contained in the coal is transformed into ammonia or liquid bases. A ton of common bituminous coal will yield 300 pounds of gasoline, 400 pounds of heavier oils suitable for Diesel internal-combustion engines, 120 pounds of lubricating oils and 160 pounds of fuel oils. As a rule, about 45 gallons of marketable gasoline can be expected from a ton of soft coal. The second fraction of heavier oils is used in impregnating another batch of powdered coal. Among the products of the process is a quantity of carbolic acid or phenol, a familiar antiseptic and also a component of bakelite, used in radio and phonographs.

"A difficulty of the process, formerly regarded as insuperable, is the high cost of hydrogen. But Bergius gets a sufficient quantity of hydrogen out of the gaseous products of the reaction. Methane, one of these gases, gives four times its volume of hydrogen, when decomposed by steam. The Bergius process can be annexed to an ordinary gas-producing plant, converting the coke into more valuable oils and enabling inferior coal to be used. Dr. Bergius was asked whether his process would pay in the United States but declined to commit himself on the ground of his inexperience with American conditions. He ventured, however, to estimate that the various oil products could be made here at a cost of about ten dollars a ton."

The full report of the Conference, illustrated and bound like any other volume, may be obtained, postpaid, for seven dollars, from the Carnegie Institute of Technology or from the Scientific American.

The Sphinx, Recently Renovated, Is Still a Mystery

VISITORS to Cairo can now see the Sphinx, probably the most intriguing and universally known monument in the world, as it appeared when first erected. And the huge dimensions and curious contour of the monument is a revelation to everyone. The fact is, says Harold J. Shepstone, we have not yet learned all the secrets of the Sphinx. For example, no one knows why it was



This diagram, prepared by Dr. Bergius, shows a Bergin plant operating in connection with a plant for the separation of hydro-carbons from the gas

built, or exactly when, or by whose orders.

The decision of the Antiquities Department of the Egyptian Government to remove the sand which partially enveloped the monument and carry out certain repair work on the neck and face was a happy one. All told, the work occupied six months. No doubt such an important archeological undertaking would have attracted much wider attention had it not been overshadowed by other discoveries at Sakkara and the Pyramids, coupled also with the unwrapping of Tutankhamen and the arrival of his marvelous golden coffin at Cairo. The excavation of the Sphinx lacked the popular glamour of gold and precious objects, for so far it has afforded none of these and it is not likely to do so.

In addition to masons and other specialists, an army of 800 girls and boys were requisitioned to clear away the sand. The latter toiled in gangs. Attached to each gang was a hired singer, usually a small boy, who chanted over and over again in a high, fascinating voice some such apparently irrelevant phrase as "*Dis Maloo ala kaloo*" ("He spent all his money on himself"), as his fellows passed to and fro with the debris.

The Sphinx has been much damaged in the past. Mohammed Ali used the monument as a target for his artillery practice. Religious fanatics have tried to destroy its beauty. The legend of chambers of hidden gold in the Sphinx has led to some violent searchings. A hole six feet deep and two feet across had been hewn in the top of the head. There was a similar hole in the left foreleg. These have now been filled up. The monument was also battered by weather, the face crumbling away.

Now that the sand has been cleared away, the magnificent proportions of the monument are apparent. It is partly hewn out of the solid rock and partly built up with stone. In fact, it is the largest piece of sculpture in the world. From the toes on the forelegs to the end of its quarters the monument measures no less than 240 feet in length, and stands some 65 feet in total height. From chin to crown the face measures 33 feet. The mouth is seven and one-half feet across, the nose is five and one-half feet long, and the ear five feet in length.

Between the huge paws there was a shrine, and here was found an inscribed granite slab, or *stela*, set up by Thothmes IV. According to the inscription, Thothmes, when a young man, went lion-hunting in the desert and rested at midday in the shadow of the Sphinx, which even then was half buried in sand. While he slept, he dreamed that the sun god Hermachis, to whom the Sphinx was sacred, appeared to him and told him that he would be a king, and laid an oath on him to dig away "the sand whereon I have my being, which has closed me in on all sides." The young man came to the throne as Thothmes IV, and one of the first things he did was to dig away the sand and restore the sacred monument.

Unfortunately, the last few lines of the inscription on the *stela* are illegible. This is a great pity, as they evidently refer to the building of the Sphinx. One gathers, by skipping a few of the gaps, that the monument was built about 3700 B.C. by Kepheron of the IV Dynasty, who built the smaller of the great pyramids close by. But another tablet found, however, would appear to indicate that the Sphinx was standing long before Kepheron's time, when Cheops, a predecessor of Kepheron, was busy erecting the Great Pyramid. Some archeologists have put the date earlier still. In any case, we know the monument is at least 5700 years old, and probably well over 6000 years.

Thothmes not only cleared away the sand which encumbered the monument, but caused all but its head to be encased in wonderful limestone masonry about one foot thick. This still remains almost perfect on the legs and lower portion of the body, and, as is seen from our illustrations, greatly alters the proportions of the great lion, making the head appear very small by comparison with the forelegs. Thothmes also painted the Sphinx a dark red all over, and much of this ancient color still remains on the head and legs.

Thothmes, in fact, did, in 1700 B.C., much the same in the way of cleaning and repairing the monument as that which has just been carried out by the Egyptian Government. If anything, however, the excavations have rendered this great piece of sculpture more mysterious than ever. We are startled by its enormous proportions. We wonder what is really the meaning of this figure of a crouching lion with a man's head. We know it represents Hermachis, the god of the sun, and that is about all. It is thought by many that a temple stood between its forelegs where the ancient Egyptians came to worship the rising sun, for the monument faces east, standing on a rocky plateau on the very edge of the desert, looking towards the Nile.

Despite the battering which the monument has received from the weather and from the hand of man, it still maintains a super-human dignity. It seems to have a far-off, dreamy, weary look. There is a wonderful sensitiveness about the mouth and the general expression of the monument is enigmatical. And these attributes are all the more pronounced now that the Sphinx has been uncovered.

Left: A rear view of the Sphinx, showing the contour. The construction is shown here

Right: Removing the scaffolding. Notice the inscribed stone between the huge forepaws

A GEOLOGICAL summer school on wheels, housed in a specially constructed sleeping, dining and lecture Pullman car, will roll this year from the Atlantic to the Pacific over Canada's great mineral empire. The trip, extending from July 15 to August 25, will be under the auspices of Princeton University and under the direction of Prof. Richard M. Field.

As foreign guests, two eminent geologists, Prof. Leon W. Collet of the University of Geneva and Dr. E. B. Bailey of the Scottish Geological Survey, will accompany the party of 23, which will include professors and practicing geologists as well as undergraduates and graduate students.

By living and traveling in the special car, a new mine or geological site can be visited nearly every day. The Canadian Geological Survey will cooperate in the instruction. Last year a similar trip was made across the United States and the combination of lectures while enroute and field experiences was proved to be a highly efficient method of instruction.—*Science Service.*

Radio Notes

A Monthly Review of Progress in Wireless Communication

CONDUCTED BY ORRIN E. DUNLAP, JR.

New Tube Uses Alternating Current

A NEW vacuum tube which derives its energy from the house-lighting current is being manufactured in Great Britain by the Marconi Osram Valve Company. The use of this tube is limited to alternating current, being operated through a step-down transformer without a rectifying circuit.

Electronic emission takes place from a cathode, a tiny cylinder coated with radioactive substance, which encloses the filament. When the filament is at white heat, the cylinder surrounding it, being heated by radiation, gives off a high electron flow. This cylinder remains unaffected by any small changes in the temperature of the filament, and therefore the electron flow remains unchanged, according to reports from England.

A grid and plate surround the cylinder in the usual manner of British-made tubes. It takes some time for the tube to start functioning after switching on the heater current, owing to the cylinder requiring to be raised to a certain temperature before the emission begins.

Engineer Predicts Television Receivers

RALPH H. LANGLEY, radio engineer who had charge of set development for the General Electric Company at Schenectady for several years, has been appointed assistant to the president of the Crosley Radio Corporation. Mr. Langley already has assumed his duties and will be the adviser of Powel Crosley, Jr., in technical and scientific matters.

"The near future will bring the development of a combined receiving set and television apparatus," said Mr. Langley, upon taking up his new position. "Both mechanisms will be controlled by the same dial. The loudspeaker will be located behind the screen and a turn of the dial will bring in music and pictures simultaneously."

Langenberg Station

EUROPE'S largest broadcasting station at Langenberg, in the Rhineland, operates on 25 kilowatts and a wavelength of 468.8 meters. Britain is building a new station at Daventry to be known as Daventry Junior, with a power output of 50 kilowatts, on the 400-meter wave.

"Britain does not intend to be shouted down in the ether by Germany," says an English observer.

Canadian Station Uses Special Tubes

STATION CFRB, operating on a wavelength of 291 meters, the latest Canadian broadcaster, is located 25 miles north of Toronto at an altitude of 1050 feet above sea level. The isolated position and high altitude were selected to avoid absorption and reflection of the waves.

Two 100-foot masts support a four-wire flat-top antenna, into which is fed power derived from four 1000-watt water-cooled tubes. Two tubes are used as modulators and two as oscillators, forming the most powerful combination in the Dominion.

The tubes have been developed by E. S. Rogers of Toronto, and operate directly from the alternating-current house mains. The tubes are of the thimble-shaped cathode type, with raw alternating current fed to the heating elements. The plate and grid voltages are supplied from a rectifier, also operating from the alternating-current lines. Two stages of amplification with two low-impedance tubes in each stage are used in the voice amplifiers.

The programs are sent to the station over telephone lines from one of the art galleries in Toronto, where accommodations are provided for the artists.

Underwood and Underwood

The transmitter of station WVT operates on wavelengths of 600 to 3600 meters. The two large coils in the background are known as harmonic eliminators, which prevent interference with the broadcast programs

United States Leads

THE United States, with 733 stations, leads the world in the development of broadcasting, according to an international survey compiled by the Department of Commerce. There are 340 broadcast transmitters outside of this country, with the foreign stations divided as follows: Europe, 164; North America (excepting United States), 85; South America, 38; Asia, 16; Oceania, 28, Africa, 9.

Just as there is a boom in radio-station building in this country, the same thing seems to be the case elsewhere, as is shown by the fact that many foreign stations have been projected within the last six months.

Stations WGY and WJZ are the most powerful broadcasters in the world. Both are rated with an output of 50 kilowatts, although it is reported that WJZ seldom uses more than 34 kilowatts. Daventry, England, using the call 5XX, is next, with a rating of 16 kilowatts.

Always there persists the rumor that there are several mysterious Bolshevik Russian stations of tremendous power for the purpose of broadcasting propaganda, but the largest station in that country noted in the official list is ROW, at Moscow, rated at 8000 watts.

As a rule, the well-known foreign stations do not average nearly as high power as the transmitters on this side of the sea. For instance, FL, the Eiffel Tower in Paris, is using only 4000 watts, and MRD, at Toulouse, 1000 watts. The most powerful station in Austria is at Vienna, rated at 7000 watts, and BAV, the outstanding station of Belgium, in Brussels, uses only 1500 watts.

Hamburg and Munich lead the stations of Germany with 4000 watts, while the largest in Italy, IRO, at Rome, employs 3000 watts. On the other hand, a much smaller country, Lithuania, boasts of Station RKY, at Kovno, with 10,000 watts. SASF, at Karlsborg, Sweden, is 5000 watts and the most pretentious station in Switzerland, the Radio-Berne, 1500 watts.

Station 2LO in London, than which there is no more famous in Europe, is but 3000 watts. On the other hand, the

Underwood and Underwood

his equipment, designed by the Bureau of Standards, is for standardizing avelengths. The harmonic amplifier in this set establishes a standard from which transmitting stations are adjusted accuratel

Canadian station CKCW, at Burketon Junction, uses 5000 watts, and 2FC at Sydney, Australia, 2000 watts. Both Canada and Australia have almost as many 1000-watt stations as their mother country.

PWX, at Havana, and CZE, Mexico City, so frequently picked up in this country, use only 500 watts. HHK, the United States Marine Corps station at Port au Prince, Haiti, also heard in this country, is 1000 watts. Argentine boasts of no less than six 1000-watt and two 500-watt stations in Buenos Aires alone. Brazil has only a single 1000-watt station in the entire country, SQIG, in Sao Paulo, as is the case with Chile, which has a station utilizing 1200 watts at Santiago.

In all China but a single station is listed, which is operated by an American firm and has a power of about 100 watts. The largest station at present noted in Japan is only 300 watts, but Cape Town and Durban, South Africa, each have 1200-watt stations.

Engineer Compares Batteries and Eliminators

THERE has been considerable controversy of late regarding the reliability of "B" socket-power units as compared to the high-quality, heavy-duty dry-cell "B" batteries. When the first "B" socket-power outfits were proposed, it was to replace a rather inefficient type of dry-cell "B" battery, and it is a matter of recent history that many of the first socket-power units failed in providing desired relief as regards reliability and reduced cost of operation, according to Ray P. Manson, Chief Engineer of the Stromberg-Carlson Manufacturing Company.

"It must not be overlooked that with the improvements in 'B' eliminators, the dry-cell 'B' battery also has been greatly improved," said Mr. Manson. "So today, the comparison must be made between the best heavy-duty dry-cell 'B' batteries and the best designs of 'B' socket-power units.

"When considered from the best designs in each class of current supply, there are only two factors that enter into the question. First, there is the matter of uniform voltage throughout the life of the 'B' socket-power and its rectifying element, as compared to the voltage of the dry-cell 'B' battery throughout its active life. Second is the cost of operation of the 'B' socket-power unit based on the first cost spread over a period of four or five years, plus renewals of the rectifying element, as compared to the replacement costs of dry-cell 'B' batteries.

"The first question is one of uniformity of operation of the receiver, and if this is the deciding question and the 'B' socket-power unit is correctly designed to give a uniform voltage output through long periods of time, then this type of 'B' current supply naturally would be given preference over the dry cell which unfortunately has a drooping characteristic, the voltage gradually decreasing as the dry cells become worn out.

"From the standpoint of operating costs it will be found that on receivers employing a total of five tubes, the output tube being of the power type, that the largest heavy-duty dry-cell 'B' batteries will just prove-in from the cost standpoint. Thus, in locations where there are no suitable alternating-current lighting circuits from which to operate the 'B' socket-power units, dry-cell 'B' batteries can be used satisfactorily on receiving sets up to six or seven tubes, including a power output tube. When figured on a three to five-year basis, the highest priced 'B' socket-power outfits will prove-in from the first cost and operating cost standpoints, and have the additional advantage that the operating voltages will be uniform, thereby maintaining the receiving set at its highest operating efficiency at all times.

"This applies to the latest heavy-duty dry-cell 'B' batteries and the best designs of 'B' socket-power units. There is another qualification in regard to the 'B' socket-power unit that must not be overlooked—that is, the keeping of the output voltages down to a reasonable level, say 135 volts for the UX-171 power tube. If this output voltage is allowed to run 180 or over, then it may be found that the rectifying tube or element, as well as the power tube of the receiver, may have comparatively short life, say about one half that obtained when the lower 'B' voltage is employed.

"This brings out the fact that it is preferable to have a 'B' socket-power unit designed to give a uniform voltage throughout a long period of time, than one which starts with a very high voltage and through overload of the rectifying element, as well as overvoltage of the amplifying tube in the receiver, to have a comparatively short life with the same type of sloping characteristic to the voltage output, as provided when the dry-cell type of 'B' batteries are used."

Radio Business Best in October

OCTOBER is the most productive month in radio sales and June is the lowest, according to a chart compiled by the National Electrical Manufac- The sale of accessories such s batteries, loudspeakers and current-supply devices reaches a peak in November and then begins to drop off until the low point is reached in June.

The chart reveals that sales diminish rapidly in March, maintaining the decline until the latter part of June, when the upward sweep begins.

Herbert Photos

This short-wave receiver, built by T. A. Smith, of New York, uses two separate grounds and no antenna. The circuit has received Australia on 10 meters. It uses one stage of radio-frequency amplification

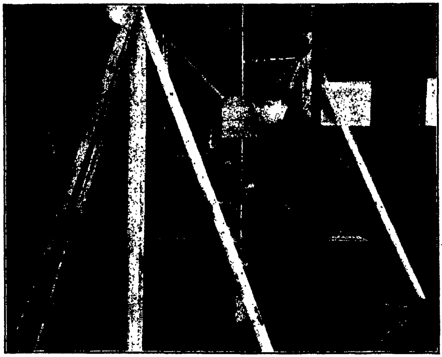
It is pointed out that better radio business is expected this summer because of the new regulations, which will minimize interference and restore law and order in the ether.

Latest Radio Studio

THE radio studio in the Roxy Theater, New York, represents, as far as acoustical properties, construction and operating convenience are concerned, the latest advance in every art which has entered into its making.

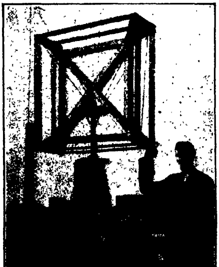
The studio is located on the fifth floor of the building, far enough above the street level to insure that traffic noises will not affect the sensitive microphones. The walls, floor and ceiling have received special treatment which makes them contribute their share to the fine tonal values of the studio, which is one of the few that has been planned and constructed especially for broadcasting purposes. The exact plans and specifications of the studio, control room, generator room and visitors' gallery were laid out in detail by broadcasting engineers working in conjunction with architects familiar with this phase of construction.

A cross-section view of the broadcasting rooms reveals that the studio proper is twice the height of the control room and the visitors' gallery. The studio is constructed without pillars or breaks in the wall surfaces which might destroy its acoustical properties. Every corner of the room, including those between the side walls and the ceiling, is a 90-degree angle. Through the middle of the ceiling, a square shaft runs to the organ loft, which contains a specially designed organ used only for broadcasting. Above the surface of the studio ceiling, in the loft, the four walls of this shaft consist of shutters, any of which may be opened to any degree, controlling the volume of the organ music which can enter the studio and the microphone, as well as allowing emphasis to be placed upon any desired portion of the music.



Harris and Ewing

This automatic loop antenna, designed at the Bureau of Standards, turns at a certain number of revolutions per hour, day and night. Thus static and other phenomena may be studied without an operator's aid



Underwood and Underwood

This loop antenna at WVT, Army Net Control Station of the Sixth Corps area at Chicago, has a wavelength range of 1000 to 3000 meters

The organ is operated from a manual in the studio directly beneath the loft. At regular intervals around the walls of the studio are microphone outlets connected with the control board. Since many different kinds of music are to be broadcast from the studio, including the work of a large chorus, many more microphone outlets have been provided than in most remote-control studios.

Machine Tests 30,000 Tubes a Day

AN automatic device which tests 30,000 radio tubes a day, whereas the most skilled human operator cannot test more than 2000 tubes in a ten-hour day, has been installed in the factory of the Westinghouse Lamp Company at Bloomfield, New Jersey. Furthermore, the human operator is bound to make occasional errors in the work, but the machine seldom makes a mistake. For the period of several months during which the machine has been in service, its record for accuracy stands at 99.9 percent. However, the 0.1 percent error is not chargeable to the machine, but, according to the engineers, to the accidental introduction of defective tubes into the good stock.

The tester consists of a revolving disk, about three feet in diameter, which carries sockets for tubes on one of its faces. As the disk revolves, the tubes are connected successively to terminals which connect them with instruments that indicate various characteristics. If a tube is found wanting, it is pushed out of its socket by an electro-magnetic plunger located in the rear of the machine.

Tubes that are hopelessly bad are unceremoniously shot into a "down-and-out" and sent to the scrap heap; but those that can be reclaimed are laid on moving belts which convey them to operators for further treatment. Perfect tubes are also placed on a belt and are carried to the wrapping department.

The points for which tubes are tested are: short circuits, broken filaments, electronic emission, gassiness, and high and low plate current. Some of these tests involve the use of extremely small currents, and special sensitive relays are employed to operate the ejecting mechanism. Each test is a positive one, and each testing mechanism operates to eject tubes in case they should be damaged during the process of testing. Hence, when the machine O. K.'s a tube, that tube is a good one.

The machine is arranged to be fed by two girls seated side by side. After it was placed in operation, the fact developed that one of the girls should be left-handed and one right-handed. A search soon disclosed a left-handed operator who, for once at least, found advantage in her peculiarity. But, alas! She is destined to lose her job soon, because the machine is being arranged to be fed automatically in order to bring it up to its full productive capacity of completely tested tubes.

Varying Wavelength

THE use of copper tubing in short-wave transmitting aerials makes it fairly simple for the broadcast station operator to vary the wavelength in an emergency. At KDKA, Pittsburgh, the wavelength may be varied by inserting a copper rod in the tubing of the horizontal counterpoise. The variation depends on the distance the rod is pushed in.

Rules For Antennas

A NEW handbook has been issued by the Bureau of Standards as a part of the national code which contains safety rules governing radio installations.

This book is known as "Number 9" and may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. The price is ten cents.

Learning To Use Our Wings

This Department Will Keep Our Readers Informed of the Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

Bellanca's Transatlantic Preparations

IN the opinion of Grover C. Loening, one of the best informed aeronautical engineers in the United States, the attempts to make a non-stop flight from New York to Paris are injuring rather than helping the cause of aviation. The non-stop flights are in the nature of "stunts." The planes are overloaded with fuel to such an extent that they become dangerous, as two fatal accidents have already shown at the time of writing. Such accidents have no bearing on ordinary commercial flying with normal wing loadings. But it is hard for the public to differentiate.

Showing the positions and weights of the parts of the load that this efficient Bellanca monoplane is designed to carry from New York to Paris

Whether the Bellanca plane will actually succeed in the flight, or whether the French pilots, Nungesser and Coli, making their attempt at the time these lines are being written will be first to achieve the crossing, is uncertain. But it is gratifying to see the care and skill with which Bellanca and his associates are making their preparations.

The Bellanca monoplane is not an experimental ship. It has been in process of design, experimental construction and test ever since 1921, and is now one of the finest examples of aeronautical construction.

The untapered monoplane wing, 46½ feet in span and six feet, seven inches in chord has a profile combining fairly high maximum lift with efficiency at cruising and maximum speeds.

The supporting structure of the wing, while amply strong, is reduced to a minimum. The struts, which must be there of necessity, are themselves of lifting airfoil section. Because of this, the struts, while offering no more resistance than the conventional struts, lift at least their own weight, and prob-

The fuselage is the greatest single item in the parasitic resistance of a plane. Aerodynamically, the fuselage is extremely sensitive to any openings or projections. For example, an improper application of windshield in an open cockpit may increase its resistance by 50 percent. In the Bellanca, in which both pilots and passengers are entirely enclosed, there is no body opening or projection to disturb the air flow.

The air-cooled engine now offers superiority in lightness and reliability over the water-cooled power plant. The sole remaining objection is in the high resistance of the projecting cylinders, and of the exhaust piping. In the Bellanca, the best modern practice has been followed in cutting down such resistance. The cowling forms a smooth line blending beautifully into the propeller spinner. The two magnetos are covered in by gentle "bosses," over which the air flows with minimum disturbance. The cowling leaves only so much of the cylinders and heads exposed as is absolutely necessary for cooling. The exhaust ring, to which each of the nine cylinders of the Wright-J engine connects, is exposed to the air blast—as is proper since the ring must not be allowed to become too hot—but it is flattened into a streamline section, as are also the exhaust stacks or stubs themselves from which the gases finally emerge.

Compared with some of the large three-engined planes, the Bellanca plane looks a little frail. But it is quite sound structurally, and good design has allowed the weight empty to be kept low.

As an ordinary commercial passenger-carrying craft, its weight distribution is as follows: Weight empty, 1850 pounds; 64 gallons of fuel, 5 gallons of oil and pilot, 579 pounds; pay load of 5 passengers and baggage, 1025 pounds. Total weight, 3454 pounds. With the wing area of 272 square feet, this gives a loading of 12.7 pounds per square foot, which is high though not excessive, and a loading per horsepower of 17.2 pounds.

The performance as given by the manufacturer gives a high speed of 130 miles per hour, and a cruising speed of 110 miles per hour when using only 125 horsepower and 11 gallons of fuel per hour.

Wide World

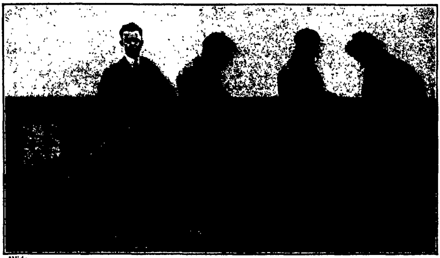
Acosta, left, and Chamberlain, who piloted the Bellanca plane in a record endurance flight of 51 hours, 11 minutes. Because of his greater weight, Acosta yielded to Chamberlain as pilot for the transatlantic flight

What is so admirable in the proposed expedition, is the careful way in which everything mechanical is being put into first class order; the exhaustive flight tests to check up fuel consumptions at various revolutions of the engine and speeds of the plane; the marvelous endurance flight of 51 hours, 11 minutes—the best possible test of the ability of plane and pilots to maintain an unbroken voyage of nearly two days duration across the ocean; and above all the care in watching weights. It was perhaps generosity in allowing weights to pile up which wrecked the hopes of both Sikorsky and Commander Davis.

Clarence D. Chamberlain and Bert Acosta, while companions in the splendid endurance flight, had become fast friends. When it came to selecting the pilot for the transatlantic trip, Acosta gracefully relinquished his claim to the position because his sturdier build meant 60 pounds more weight than that of the slim Chamberlain. The lightest gasoline tanks are used; the equipment selected is adequate but not of excessive weight; the fuel carried is enough to give a reasonable margin but no more; no presents for Paris and no luxuries are carried. The weights now stand as follows: plane empty, 1850 pounds; gasoline, 400 gallons, 2400 pounds; oil, 20 gallons, 160 pounds; radio apparatus, 60 pounds; food and water, 13 pounds; signal flares, 15 pounds; earth inductor compass, 15 pounds; octant, eight pounds; drift indicator, two pounds; special chronometer, one half pound; stop watch, one half pound; total 4891 pounds.

Of course the plane will be overloaded as compared with its ordinary commercial condition. But the overloading will not be excessive, giving only 18 pounds per square foot of wing area and 23.3 pounds per horsepower. The areodynamically efficient plane will have no difficulty in getting up sufficient speed to make a get-away. The first hours in the air will give cause for anxiety, but the hazards are at least reasonable.

At the start of the flight with full load, if cruising at 110 miles per hour, the fuel consumption would be heavier than the 11 gallons an hour quoted above. But the pilot may reduce consumption of fuel per mile by flying more slowly. As the plane lightens, the fuel consumption will go down. The figure of 11 gallons per hour at an average of 110 miles per hour may therefore be achieved. This, for a flight of 3600 miles, will mean 368 gallons of fuel, leaving a margin of 32 gallons. At the last minute, an extra 30 gallons may be stowed in the cabin in five-gallon tins. There is a fair sporting chance of getting across, or at the worst of landing on the west-coast of France without actually reaching Paris.


Wide ......

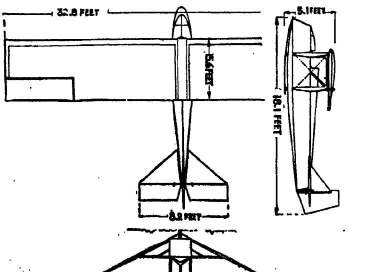
The famous glider pilot, Espenlaub, superintending the attachment of his glider to an airplane, just prior to experiments to test the practicability of discharging freight from moving planes by means of gliders

A Neat Glider

GLIDING as a sport has never taken a serious foothold in the United States. In Germany it is being pursued as intensively as ever, and various societies exist which provide their members with systematic training and subsequent practice. One such society is the Rhön-Rossiten Gesellschaft which holds its exercises *auf der Wasserkuppe* in the Rhine valley, at a spot where meteorological conditions are particularly favorable.

It is surprising how quickly students qualify as glider pilots. During the month of September, 1926, the society gave 18 elementary and 11 advanced gliding certificates. Instruction was given on 22 days of the month. There were 450 glides made, of an average duration of 30 seconds, or a total of only three and three-quarter hours of gliding time. Some of the advanced students finally managed duration glides of some seven and one half minutes. We have never heard of anything as systematic and earnest in the gliding line in the United States.

The gliders used by this society are beautiful examples of aerodynamical and structural design. Our diagram shows the *Segler R 11* (glider) on which advanced students receive instruction. It has beautiful lines and the most correct and efficient disposition of surfaces. Anyone building a glider could not go far wrong in working on similar lines.



The German glider *Segler R 11* is an excellent example of design

Towing Gliders

THE Army Air Corps has for many years been experimenting with target gliders towed behind an airplane, to be released for practice shots from anti-aircraft guns. It has remained for a German firm, the Raab-Katzenstein Airplane Company, to experiment with such gliders for commercial purposes. The airplane has a cable about a thousand feet in length attached to its fuselage, and this cable is attached to the front end of the glider, with a release which the glider pilot can readily actuate. The idea is to have the airplane act like a locomotive with a line of freight cars, and detach the freight-loaded gliders one by one as they reach their destination.

Experiments conducted by the German ace, Kieseler, in the plane, and Espenlaub, the famous glider constructor, in the towed glider, have been entirely successful, as far as safe release and landing were concerned.

From the point of view of airplane economics, however, the idea does not seem promising. For the same freight

(*Continued on page 89*)

In the World of Chemistry

A Department Devoted to the Advancements Made in Industrial and Experimental Chemistry

CONDUCTED BY D. H. KILLEFFER

A New Slant on the Smoke Nuisance

CONTROL of the smoke nuisance must depend upon the effect of smoke-laden air on health, if success is to be achieved, according to Dr. Charles White, pathologist of the United States Health Service, who points out in *American City*, that smoke prevention will be more readily secured if it can be shown that smoke-laden atmosphere has a harmful effect on the human system. The chief arguments heretofore have been for comfort and cleanliness. Data collected by him show that the city of Pittsburgh has a low tuberculosis death rate but a high pneumonia death rate, an analysis by wards showing that the higher rates occur where the smoke-laden air is denser. The number of physicians specializing in respiratory diseases is higher per capita in Pittsburgh than in Baltimore, showing a greater demand for this type in the smoke areas. The evidence indicates that smoke must be controlled from the viewpoint of its effects upon public health.

Artificial Ripening of Fruits and Vegetables

THE storing of fruits and vegetables in an unripe condition and then ripening them as required by the conditions of the market, is forecast by Dr. R. B. Harvey, Associate Professor of Plant Physiology and Botany at the Minnesota College of Agriculture, as a result of an extensive research on the action of ethylene and propylene on fruits and vegetables. In the past, ethylene has been used for coloring citrus fruits and by its use it has been possible to make green fruit appear ripe, which was none too proper. However, Dr. Harvey has found that by continued application of either ethylene or propylene, an actually green fruit can be made to undergo exactly the same changes in composition that occur in ripening on the plant. In discussing his results in an article published in the *Chemical Bulletin* (Chicago), Dr. Harvey says in part:

"At the Minnesota Experimental Station we have now ripened practically all of the important fruits and vegetables of tropical and temperate climates, so that ethylene seems to have widespread application. It is useful in removing excess acidity from early apples, plums, rhubarb, pineapples, and other fruits. It will produce better flavor in musk, honey-dew, and casaba melons. Of the tropical fruits, we may now hope to have a greater share available in the north. The mango, avocado, papaya, custard apple, chayote, jujube, and persimmon offer commercial possibilities since they may now be shipped in a firm green condition. In Minnesota, during most of the year, quantities of fresh tomatoes are imported, sometimes with the loss of half of the car by the old method of heat treatment. Possibly we should look to the advantage of future generations of northern races in having fruits from the tropics available throughout the year as much as to the money saving through decreasing the loss of human food materials.

"Ethylene is the most practical gas for use in ripening, although propylene is a little more active and produces a little better flavor in fruits. Propylene is not available commercially at present. Acetylene is considerably more toxic than ethylene or propylene and has an unpleasant odor in the comercially available product. Ethylene can be obtained in cylinders.

"A measuring gage can be made by attaching a calibrated orifice to an ordinary low-pressure expansion valve, although there is a convenient valve already on the market calibrated to deliver a regulated amount of ethylene gas per minute. Other than this simple equipment, all that is necessary is to have a banana room or similar room tight enough to prevent excessive leakage of gas. This room must be kept at 65 to 70 degrees, Fahrenheit. At temperatures below 65 degrees, Fahrenheit, ripening is slow. Temperatures above 70 degrees, Fahrenheit, may be used for some fruits, but rots may develop too rapidly. At 65 degrees, Fahrenheit, only 48 hours are required to ripen bananas from a very green state.

"Ethylene is not explosive at concentrations many times the required concentration (1-1000). It is practically odorless and not poisonous. No effect on men working in the treating rooms is detectable. The gas has almost exactly the density of air and diffuses quickly throughout crates of celery or through loose boxes of fruit.

"Ethylene may be used to remove the excess acidity of fruits or vegetables, to remove chlorophyll from celery or similar plants, to increase the sugar content, or to remove tannins and other objectionable substances. Tomatoes ripened after removal from the vine in winter are liable to be excessively acid, but if treated with ethylene they have a fine flavor, free from excess acidity. Very immature tomatoes down to one inch in diameter may be ripened in six to eight days; more mature fruits require only 24 to 60 hours, depending upon the variety and degree of maturity. It is practicable to ripen two-thirds or three-fourths size tomatoes for the market at times of high prices. Tomatoes have better flavor when so ripened than those ripened on the vine. This will make it possible to extend the length of the season by ripening immature fruits before the regular season, and also will save fruits caught green by frost.

"Celery can be blanched perfectly in 60 hours and has a fine color, sweeter taste, and less stringiness. A single dose of ethylene, about two to three cubic feet, costing less than 40 cents per carload of fruit, is sufficient to produce a remarkable change in the time required to ripen bananas, and to change their color, flavor, and texture to that of fine, ripe fruit. The tannins of the date and of the Japanese persimmon have been more quickly removed than is possible without ethylene. The astringent Japanese persimmons were nicely ripened in 50 hours with ethylene, while controls at the same temperature were still very astringent. Ethylene causes a sudden jump in the respiratory rate after its application. Attendant with this increased rate of respiration, the fruit acids and tannins disappear."

This process has been in practical use for some time with extremely satisfactory results.

Carbon Monoxide in Automobile Service Stations

SINCE the exhaust of an automobile engine contains nearly 6½ percent of carbon monoxide, employees of service stations are subject to a severe hazard from carbon monoxide poisoning. Dr. May R. Mayers, of the Bureau of Industrial Hygiene of the New York State Department of Labor, is carrying on an investigation of methods of combating this hazard and in the *Industrial Hygiene Bulletin* of the Bureau says:

"Various methods are being experimented with by the automobile industry at the present time with a view to ridding their service stations of the carbon-monoxide hazard. The installation of elaborate forced-draft ventilating systems, capable of keeping the air fresh at all times appears to be far too expensive to be practicable in most instances. Instead therefore, managers of service stations are becoming interested in the use of various chemical substances now on sale, which if sprayed, or otherwise introduced into the air are supposed to 'improve the condition of the air.' Just how this is to be accomplished is frequently very vague both in the minds of the manufacturers of these products and those who purchase them for their service stations.

"The Bureau of Industrial Hygiene has been called upon by some of the more intelligent service-station managers —particularly those having a large number of service stations to provide for—for a disinterested opinion as to the efficacy of these measures. One of the chemical substances on the market is essentially a combination of chlorine and formaldehyde which is to be sprayed into the workroom. This is now under investigation by the Bureau. The other chemical substance which is making con-

(*Continued on page 76*)

(Continued from page 74)

siderable headway in garages and service stations is ozone, chemically designated as O_3. Ozone is generated in the room by means of one or more ozone generators of varying sizes depending upon the size of the service station.

"Manufacturers of these ozone machines are not all agreed as to its effect either upon the air of the workroom or upon the men exposed. One manufacturer in his sales literature points out that ozone or O_3 is broken down into O_2 plus O, and that the one atom of nascent oxygen combines with the carbon monoxide in the air to form carbon dioxide which in the concentration produced would be quite harmless, $(O+CO \rightarrow CO_2)$. In this contention he is not supported either by the other manufacturers of these machines or by experimental evidence. That under conditions prevalent in service stations, this reaction does not occur to any appreciable extent whatever is well established scientifically. This conclusion has further been independently arrived at and confirmed by experimental work conducted by the Bureau of Industrial Hygiene.

"The fact that many of the men working in service stations where these machines have been installed 'on approval' appear to be genuinely enthusiastic about them, however, and claim that they feel so much better and have fewer or no headaches since their installation, has caused the Bureau of Industrial Hygiene to investigate the matter further. It has been our experience as a result of an examination of a considerable number of these men that exposure to carbon monoxide seems to make them hyper-suggestible. The question immediately arose, therefore, whether perhaps the sole effect of these machines was psychological. On the other hand, the men continue to insist that they really do have fewer headaches, and some claim to have none at all any more since the ozone machines have been installed. The carbon-monoxide headache is too real and too intense to be disposed of purely by suggestion."

Glaucosil

CHARCOAL and a number of other things have the desirable property of being able to absorb huge v[illegible] gaseous and liquid materials, as witness the use of a piece of charcoal in the family ice box to absorb food odors. This property of absorption, or adsorption as it is more correctly called, is valuable in many industries, and much effort has been devoted to increasing the adsorptive capacity of charcoals. This has resulted in the development of a whole host of "activiated carbons" possessing very high power of adsorption, and in addition to the activated carbons, several types of highly adsorptive silica have been developed which can be used for a number of things for which charcoal is unsuited. The most recent of these has been developed in the Bureau of Soils at Washington as one of the products obtained along with potash and other materials from greensand, and is called glauconite. The new industry of obtaining potash from

(Continued on page 84)

Applied Science for the Amateur

A Department Devoted To the Presentation of Useful Ideas. Material of Value To All Will Be Found Here

CONDUCTED BY A. P. PECK

Photomicrography Made Simple

THE writer is one of the undoubtedly large number of amateur scientists who delight in exploring the realms of minute objects that are revealed to us through the medium of the microscope.

Here is shown the complete layout for photomicrography. A high-power microscope is in the stand; a low-power one is at the right

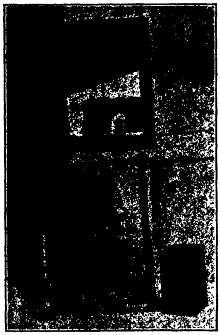
In studying objects and their structure through a microscope, I have often desired a method whereby I could obtain a permanent record of the observations. Not being a master of the technique of drawing, the field of photography seemed to offer the only logical solution. However, the available literature on the subject of photomicrography stated that elaborate equipment was necessary for the taking of photomicrographs. I found that I could not afford such apparatus, so I set to work to prepare a system whereby, with comparatively cheap equipment, coupled with a good microscope, I could produce satisfactory results.

After some little experimenting, I found that with the simple apparatus shown in the accompanying photographs, I could take very good photomicrographs. Several samples of the work done with my equipment are shown also.

Aside from the microscope, the essential parts of the apparatus are three in number. First, there must be a cheap box camera, of a type in which the back is removable. Such a camera need not cost more than two dollars. Secondly, a stand for the camera and the microscope is to be made. This is shown in the photographs.

The third part is a source of light. I used a 100-watt lamp and a thin-walled, globular glass bulb filled with distilled water. The latter is used as a condensing lens for converging the beams from the electric lamp to the microscope mirror. This bulb of water is to be arranged so that it can be moved vertically, so as to make it possible to direct the beams as desired. A fine ground-glass plate is placed between the source of light and the glass bulb. Also, a properly ventilated metal housing should be provided for the electric lamp.

The stand for the microscope and the camera is worthy of special notice. It must be constructed rigidly so that there will be no chance of vibration of the camera during exposure. Due to the variations in the sizes of microscopes, no definite dimensions are given. However, the base, sides and top should be

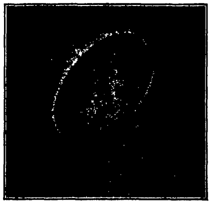


The microscope and camera stand with the camera removed. A mirror is arranged to show the reader the construction of the top and the placement of the bolts

cut from one-inch stock, and securely fastened together with screws, not nails. A properly shaped block screwed to the base serves at all times to hold the microscope in the same position relative to the top. This is clearly shown in the photographs.

The square nuts on two bolts through the top serve to help the operator to place the camera in the proper position after it has been removed for the purpose of focusing the microscope or inserting the film. As shown in the mirror in one of the photographs, these are set in slots, so that when loosened, the bolts can be shifted to accomodate the particular camera used.

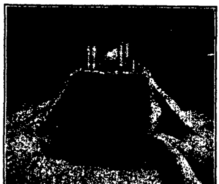
Before attempting to take photomicrographs, the lens in the camera is



removed, as it is of no use in this work. Then the camera, with the back removed, and without any film in it, is placed over the opening in the top board. The microscope is placed in its position on the base, and a piece of ground glass is laid on the back of the camera. The stand should be of such height that the eyepiece of the microscope will be fairly close to the opening of the camera. The farther away it is, the smaller will be the resulting picture.

When the light and mirror of the microscope are adjusted, a circle of light will be seen on the ground glass. The position of the camera should be shifted until this circle occupies the center of the glass. Then the nuts are tightened so that camera will always be replaced in the same location. These nuts do not

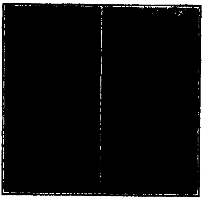
(*Continued on page* 80)



The eyepieces used. The top of each is placed to the right of it. Micrometer focusing eyepiece is shown at the extreme right

clamp the camera but serve as guides.

In the actual taking of the photomicrographs, the microscope is focused with the eye in the usual way, with the camera removed. Then the camera, with first film in position, is placed against the two square nuts. With the room in darkness and the microscope light turned off, the shutter is opened. Then the light is turned on, the exposure made, the light turned off, and the shutter closed. Be sure to follow this sequence, because opening the shutter while the light is on will tend to shake the camera and spoil the photograph. Do not move around the room while the shutter is open, and be sure that there

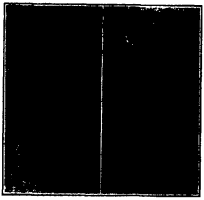


Both parts show vinegar bacteria. Left: magnified 675 diameters. Right: 1800 diameters

will be no other disturbing vibration while the exposure is being made.

The exposure for this work will vary from 10 to 30 seconds, according to the subject on the slide, the strength of the light and the power of the lens combination being used.

The foregoing paragraphs deal with ordinary photomicrography. However, I have recently developed a method of very sharp focusing, by means of which it is possible to photograph bacteria, using a high-powered microscope. For this work it is necessary to have an instrument which is made so that different eyepieces can be used. You will also need two eyepieces, or oculars. One, which I will refer to as number



Human hairs cut transversely. Left view is magnified 675 diameters; right 1800 diameters

one, is an ordinary ocular magnifying between 10 and 15 diameters. The second, which I will call number two, is termed a "micrometer focusing eyepiece" and can be obtained in two powers, namely seven and 17 diameters. This can be purchased without the

more expensive micrometer attachment.

The following process for delicate work, and using the 17 power, number two ocular, is to be recommended.

Place the microscope, containing ocular number one, in the stand and focus in the regular way, using the eye. Now remove number one and substitute ocular number two. Place the camera, unloaded, on the stand and, without altering any of the former adjustments, focus sharply on the ground glass by carefully turning the upper part of ocular number two. When this has been done, remove the camera, load with film, replace and make the exposure.

A ribbed diatom, photographed using magnification of 675 times

Once these adjustments have been made, they need not be touched unless the magnification power of the microscope is altered.

When stained micro-organisms are to be photographed, the best results will be obtained with those stained red or brown, in preference to blue. This is particularly true if a color filter of the type known as K2 is employed.

There is a vast field open for experimentation in this line. The above is only a very brief resume of my work, and undoubtedly others will discover better methods than mine. To those that take up the work, let it be said that the results will depend on the amount of time expended. Experimentation with the time of exposure, color filters and focusing methods will reveal more definite data which can be followed for best results.—*Contributed by A. C. Lonert.*

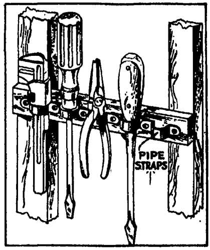
Photograph of pollen grains from a rose, magnified 135 diameters

[We particularly recommend this item to our readers. It shows the true spirit of the experimenter in overcoming obstacles. Since trade names have been

omitted, the names and addresses of companies that supply microscopes, special eyepieces, color filters and other supplies for the microscopist will be mailed upon request. *The Editor.*]

Tool Rack

WRITING in *Power*, Mr. H. L. Wheeler, of Syracuse, New York, tells of a rack of small tools that is very easy to make and of great value in the



Tool holder made of pipe straps

orkshop. Such a rack is illustrated in these columns, and the following paragraphs are what Mr. Wheeler has to say about the arrangement.

"A rack made of miscellaneous sizes of pipe straps, as shown in the illustration, makes a handy resting place for small tools around the engineer's work bench. Such tools as screwdrivers, chisels and pliers, may be hung within convenient reach. Each may have its proper place where it will be on the job whenever needed.

"To make the rack, nail a piece of one by two inch board about ten inches higher than the bench. To this strip nail or screw the pipe straps, one lapping over the other. Provision can be made for many different small tools by using the several sizes of pipe straps."

Perspecti

REFERRING to the item on stereoscopic photography in the March, 1927, issue of this magazine, Mr. George P. Sanborn sends an interesting item regarding the use of photographs produced by the described method, by means of which it is possible sometimes to do away with the usual stereoscope. The system, which the editor has tried out successfully on occassion, is described in the following paragraphs. It is well to note that all persons do not obtain the same effect, and that all stereoscopic prints are not suitable for the work.

As a preparatory measure, prior to trying a "double" or stereoscopic print, make two black dots about three inches apart on a white card. Hold the card a few inches from the eyes, and in such a position that a line connecting the dots will be parallel with a line connecting the eyes. Focus the eyes on an imaginary spot between the two dots

and some distance behind the card. Soon, if the conditions are right, the two dots will appear to coalesce, and *three* dots will appear—the third one, which is apparent and not real, about half way between the two actual dots. This effect shows that the trick has been acquired and you can now try a stereoscopic print.

When doing this, proceed in the same manner as described for the white card, using a print that has some particularly striking feature. When this feature on one of the prints appears to coalesce with the same part on the other print, the picture will appear to stand out in full perspective. Some practice will be necessary before the best results can be obtained.

Counterbalance Weight

I WANTED an accurate, presentable counterbalance for a ventilator door, as I did not wish to leave my experimental assortment of bits of iron hanging to the end of the pulley rope. Two old fruit-jar lids and a piece of discarded inner tube from an automobile were the essentials for a neater weight.

One end of the tube was tied securely over one of the lids. I then filled the tube with coarse sand until it weighed exactly as much as my trial conglomeration of iron. A hole was punched in the other lid, and a hook inserted. This was made of heavy wire with a circular

over the inner surface of the cover. This cover was pushed down into the tube, expanding it to a straight cylinder and closely packing the sand. It was quickly made, "filled the bill," and I

think was just a bit more neat, accurate, and safe than any other small counterbalance of its kind I have ever seen.
—*Contributed by Frank W. Bentley, Jr.*

In the World of Chemistry

(Continued from page 76)

this source is in a state of rapid development and investigations are being made of the efficiency of the by-product, glaucosil, as compared to other similar materials.

In reporting an investigation of the subject before the American Chemical Society, Whittaker and Fox of the Bureau of Soils state:

"Glaucosil is the siliceous residue obtained by extracting greensand with mineral acids, preferably sulfuric acid. The acid leach is treated to recover potassium salts, iron and aluminum oxides, and fuming sulfuric acid. Glaucosil is thus obtained simultaneously with other products and is, in short, a by-product of the manufacture of potash and other materials from greensand. The siliceous residue as obtained in the process contains only such salts as are present in the mother liquor and these are easily removed by washing.

"Glaucosil is practically pure silica. It differs from artificial active silica in that it has never been through the gel stage, unless perhaps it went through such a stage in the geological ages when the greensand from which it is derived was formed. It is simply the silica skeleton of the greensand granule, the surfaces of which, both inner and outer, have been cleared off and left in a highly active state by the action of the acid. It is never in solution, colloidal or otherwise, during its manufacture. Chemically it is quite active, much more so than any crystalline silica. It dissolves readily in dilute caustic by simple warming. Acids apparently leave it entirely unattacked."

After a careful study of the comparative adsorption of benzene, xylene, carbon tetrachloride and water by it, these investigators point out that glaucosil has a high activity and adsorption capacity as compared with other similar materials. They conclude from their investigations that the by-product of this new industry will find wide industrial application and compare the saturation values with those obtained by [illegible] and Johnson with aluminum [illegible] and by Patrick and Opdycke on silica gel. Saturated or nearly saturated vapors were used in each case. The accompanying table gives a comparison of the three adsorbents under test conditions.

Relative Adsorptive Capacity of Glaucosil, Aluminum Oxide, and Silica Gel

			Carbon tetrachloride
	Degrees Centigrade	*Percent*	*Percent*
Glaucosil	25	40.5	61.0
Aluminum oxide	20	16.0	29.0
Silica-gel	30	24.6	44.9

Selenious Acid as a Weed Killer

DANDELIONS and other weeds, which cause the makers of lawns so much trouble, may yield to a treatment with selenious acid, a derivative of the metal selenium so often spoken of because of its changes in electrical resistance under the influence of light.

Norman W. Stover and B. S. Hopkins of the University of Illinois report on a recent investigation of the action of selenium and tellurium compounds on fungi and bacteria in *Industrial and Engineering Chemistry*, and add to their remarks these pertinent paragraphs on the control of weed growth:

"It would seem probable that, under normal weather conditions, selenious acid in a concentration of 0.005 normal could be used as a spray to check the growth of dandelions in lawns and yet not permanently injure grass.

"The results of similar work on other weeds may be summed up as follows: Canada thistle was killed by spraying in the late fall with 0.02 normal selenious acid, whereas summer spraying did not prove successful. Burdock was readily killed by 0.02 normal selenious acid by spraying in mid-summer. For plantain and pigweed, selenious acid in concentrations of at least 0.05 normal were required to actually kill the plants. The results of experiments on poison were not definite."

Waste Sulfite Liquor as a Spray Mi

THE waste liquor from the manufacture of sulfite paper pulp is one of the largest single wastes of industry, and any possible use for it immediately attracts attention. The latest suggestion comes from C. S. Fleming and J. H. Reedy of the University of Illinois who report, in *Chemical and Metallurgical Engineering*, successful tests of as an insecticide and fungicide for agricultural use. Their process consists in saturating the liquor with hydrogen sulfide and using this as a spray after the chemical reactions have had time for completion. Such a solution is very similar to the standard lime-sulfur spray now widely used.

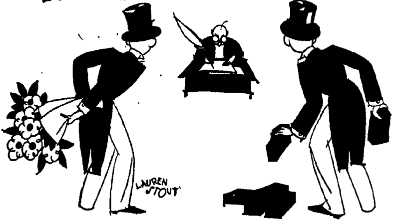
A Test For Pin Holes in Metal Coating

SOME time ago in this department a description was given of the so-called "ferroxyl" corrosion test. The application of this to practical purposes is rather difficult, and recently, in conversation with Professor Edwin M. Baker of the University of Michigan, we learned of a more convenient method of applying this test to the detection of pin holes in electroplates on iron work. A solution is prepared of two grams of potassium ferricyanide (red prussiate of potash) and ten grams of salt (sodium chloride), in 250 cubic centimeters of water. Strips of filter paper of convenient size are saturated with this solution and dried. These strips of filter paper can be kept indefinitely for use. To detect faults in nickel plated work, a strip of this paper is moistened and spread carefully over the sample in such a way that no air bubbles are retained beneath it. Pin holes show up within a very few minutes as blue spots on the paper. These spots are permanent and after drying the paper record of them can be preserved for reference.

Alcohol For Diluting Gasoline

FOLLOWING the precedent set by France, the Italian Government has decreed that all gasoline used in that country must be diluted with alcohol.

IN THE EDITOR'S MAIL



A Helicopter

AN interesting photograph of a helicopter which one of our readers has designed and built, is reproduced in these columns. We print below some details of the machine as furnished by the inventor.

Editor, SCIENTIFIC AMERICAN:

My helicopter may now be termed a partial success. On a recent test, I had some hard luck with it, stripping the transmission gears. This happened when I opened the throttle suddenly, and the machine had just started to rise from the ground. I am now changing the design of the wings, and will install a larger motor, whereupon I have great hopes for further success. The following paragraph gives some of the details of the present machine:

A Lawrence 28-horsepower motor is employed. The wings are of the Spad type, measuring 25 feet from tip to tip. The fuselage is 23 feet in length and the entire machine when empty weighs 750 pounds.

Yours very truly,
Leo Ortego.
Alexandria, Louisiana.

Used in Sern

JUST now, when anti-evolutionists are banging away at science, it is rather refreshing to receive word from a clergyman that he is using the SCIENTIFIC AMERICAN for obtaining ideas for use in sermons. A Jesuit priest in a remotely located parish writes us as follows:

Editor, SCIENTIFIC AMERICAN:

"It has been some years since I have come across the SCIENTIFIC AMERICAN in our Jesuit Colleges. Marooned here on a small island, and in a small parish residence, one has little chance to have many books for reading.

What is found in your magazine may come in handy by way of illustrations in sermons, conversation, et cetera.

I was agreeably surprised to find that the magazine had increased considerably in bulk.

Sincerely,
Rev. A. L. Maureau, S. J.
St. Mary's Church, Star of the Sea,
Key West, Florida.

Venerable

THE SCIENTIFIC AMERICAN was founded in 1845 and is therefore read by life-long readers of all ages. Some who "formed the habit" years ago still keep it up. Here is a letter from an octogenarian who expects to read pages 21 years more. May he be able to do so.

Editor, SCIENTIFIC AMERICAN:

I will be 83 years on the 29th of January, 1927, and after that date—should I live to be as old as my

in the air. Some details of it are given in the text above

grandfather Coombs was, I will then be 104 years old, or 21 years older than I am now.

I was told by reliable parties who knew my grandparents, the Clark and Bryant families, that my grandfather Clark and his wife lived a lifetime of a hundred years each, near Damacotta, Maine, and raised twenty children—all healthy.

I would ask, why have the healthy, Christian men and women quit raising such families nowadays?

C. E. Clark,
Boise, Idaho.

P. S.—If I should live 21 years more you can count on me sending my subscription of four dollars in advance every year, because I would not like to miss a single issue of the SCIENTIFIC AMERICAN.

Science Teacher Makes Home-Made Telescope

IN these columns we reproduce a photograph of a reflecting telescope made by a physics instructor in the Fort Dodge, Iowa, High School. Science teachers who can thus demonstrate by means of their own handiwork that the things they are teaching are real instead of mere "book science," must surely inspire their pupils with enhanced interest in their studies. Writes Mr. Bloxom:

Mr. Bloxom and his reflecting telescope, made from cardboard tube and a rigid music stand

Editor, SCIENTIFIC AMERICAN:

With the aid of your book, "Amateur Telescope Making," I succeeded in producing an interesting little telescope at an extremely small expense, and one that I find very useful in the study of astronomy and optics in my science classes.

The mirror was cut from ordinary plate glass and is four and one half inches in diameter, having a focal length of 44 inches. The tube consists of rigid cardboard formerly

used shipping rugs, and all other parts are equally light. Notice the floating eye-piece arranged to be turned to different positions at leisure. Notice also that a laboratory clamp and a bent rod give hints of an equatorial mounting. The telescope is quite portable, weighing only 9¾ pounds complete.

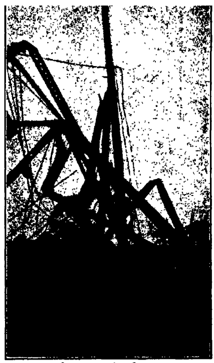
It might be interesting to the amateurs to know that a tiny glass bead picked from a lamp shade and glued over the pin-hole served to diffuse the light from an unfrosted light globe for the purpose of testing the mirror according to Foucault's plan.

The SCIENTIFIC AMERICAN is doing much to encourage the study of science in the schools, and though this telescope is very modest in dimension, I have personally profited, both directly and indirectly, from the experiment. I began the project on a rainy day, not convinced of its wiles, but retaining the idea that sunshine might change my plans. Clear skies have strengthened my plans; I hope to build a ten-inch telescope soon. Lend my encouragement to the amateurs.

Very truly yours,
H. Lynn Bloxom.

Freak of a Storm

VIOLENT storms in various sectio of the country frequently leave exar ples of their vagaries in various form



One freak result of a storm

Here is the record of another, as sent to us by one of our Texas correspondents:

Editor, SCIENTIFIC AMERICAN:

r a picture taken in ... xas, shortly after ... of April 12, 1927. Showing as it does the velocity of the wind that would crumple such steel—and also showing the freakish prank of the wind in not harming the wooden poles so near it—I believe that you will be able to use it.

Very truly yours,
Robert W. Jacobs.

Learning to Use Our Wings

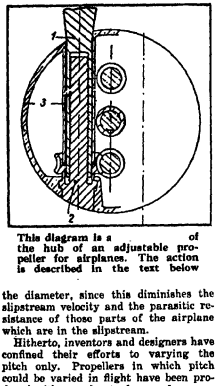
(*Continued from page* 73)

load, the air resistance of an airplai towing a string of gliders is likely be greater than the air resistance of single aircraft. The structural weig... of the towing combination is also likely to be greater than the structural weight of a single airplane carrying the same pay load.

Unless the convenience of being able to discharge freight without landing proves to have great advantages, the experiment is likely to remain just a clever "stunt."

Propeller Design

WHEN an airplane is climbing, it is advantageous to reduce the pitch of the propeller, since the speed on the climb is much less than at maximum speed, while the revolutions per minute diminish only a few percent. At the same time it is advantageous to increase



This diagram is a of the hub of an adjustable propeller for airplanes. The action is described in the text below

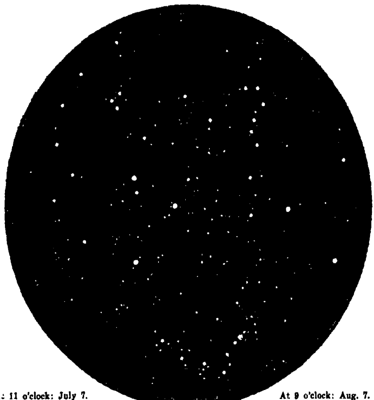
the diameter, since this diminishes the slipstream velocity and the parasitic resistance of those parts of the airplane which are in the slipstream.

Hitherto, inventors and designers have confined their efforts to varying the pitch only. Propellers in which pitch could be varied in flight have been produced with a moderate degree of success, but on the whole it has been found more practical to design mechanisms in which pitch could be varied only on the ground.

The invention of M. G. Rouilleit, of Paris, recently described in *Les Ailes*, allows both pitch and diameter to be varied on the ground, and may therefore be of real value. The working mechanism shown in the sketch is rather briefly described, and the sketch itself is difficult to understand completely. It would appear that the airscrew blades terminate in a cylindrical part, 1, provided with an inner thread. The outer side of this cylindrical piece is provided with grooves which connect it with the propeller hub, 3. The spindle, 2, is connected with the hub by a cog, and also carries a worm which is driven by a worm-wheel. By turning the worm-wheel, the blades can be moved in and out at will with simultaneous variation of the pitch.

The Heavens in July

BY PROF. HENRY NORRIS RUSSELL, Ph.D.



...: 11 o'clock: July 7.
At 10½ o'clock: July 14.
At 10 o'clock: July 22.
At 9½ o'clock: July 30.
At 9 o'clock: Aug. 7.
At 8½ o'clock: Aug. .
At 8 o'clock: Aug. 22.

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on July 7, etc.

NIGHT SKY: JULY AND AUGUST

The Heavens

ON our star map this month, we find the bright star Vega almost overhead. Below it, to the southeast and high in the sky, is another bright star, Altair, flanked by a fainter one on each side. To the left, due east and high up, is the constellation Cygnus, sometimes called the "Northern Cross," and looking much more like a cross than the southern constellation of that name. Its brightest star, Deneb, looks a little fainter than Altair, and much inferior to Vega, but it is in reality very much brighter than either, and would altogether outshine them if it were not exceedingly far away in space.

Farther to the left, and still following the Milky Way, we find Cepheus and Cassiopeia. Below these galactic constellations appear Pegasus and Andromeda. The Great Nebula in the latter—which can readily be found with the aid of the map—is so remote that Deneb itself, if equally far away, would probably be visible only in the most powerful telescopes.

The Planets

Mercury is an evening star until the 20th, when he passes through inferior conjunction and becomes a morning star.

Venus is an evening star, and at her best, being at her maximum apparent distanse from the sun on the 2nd. She does not set until after 10 P.M. and is by far the most conspicuous object in the sky. With even a small telescope, her half-moon phase is easy to see.

Mars is an evening star like the others, but is getting pretty well down. He sets about 9 P.M. and looks about as bright as the Pole-star.

Jupiter is past quadrature, and is due south about 5 A.M. in the middle of the month. Saturn is in Scorpio and well visible all the evening. Uranus is in Pisces, and is in conjunction with Jupiter on the 9th, being 38 degrees north of him. This will make it easy to pick the planet up with field-glasses.

The moon is in her first quarter at 8 P.M. on the 6th; full at 2 P.M. on the 14th; in her last quarter at 10 A.M. on the 21st, and new at 1 P.M. on the 28th. She is nearest the earth on the 19th, and farthest away on the 6th.

During the month she passes near Mercury on the 1st, Mars, Neptune and Venus on the 2nd, Saturn on the 10th, Uranus and Jupiter on the 19th, Mercury again on the 27th, Neptune on the 30th and Mars later on the same day. There are therefore no less than ten planetary conjunctions with the moon this month, while last month there were only six.

Saturn is occulted at this conjunction, and the occultation is visible in the United States. As seen from Washington, the planet disappears at 4:30 P.M. and emerges at 5:31. Unfortunately, this happens in the daytime, so that a good telescope will be needed to see the phenomenon.

Commercial Property News

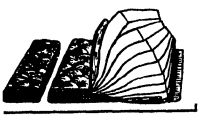
A Department of Facts and Notes of Interest to Patentees and Owners of Trademark Rights

CONDUCTED BY MILTON WRIGHT

Exaggeration is Excusable

THAT the Federal Trade will get you if you try to deceive the public is well known. But what if you merely exaggerate the qualities of the products you are selling? That, the courts believe, is a time-honored custom with which no fault can be found.

The recent experience of Ostermoor and Company is a case in point. The Ostermoor trademark is a picture of a mattress with one end open and layers of cotton felt billowing up to a height of what looks about three feet. As a matter of fact, instead of looming up to a height of thirty-five inches or more



This type of exaggeration is permissible in trademark registration

when opened, an Ostermoor mattress expands only from three to six inches. The mark has been in use about 30 years and more than 4,000,000 dollars has been spent in advertising it. The Federal Trade Commission called the use of the mark in advertising misrepresentation, falsity and deception amounting to unfair competition and ordered the company to stop using it. The case went up to the Circuit Court of Appeals for the Second Circuit.

"The time-honored custom of at least merely slightly puffing, unlike the clear misrepresentation of the character of goods, has not come under the ban," Judge Mack finds. "Concededly it is an exaggeration of the actual condition; indeed petitioner asserts that it is not and was not intended to be descriptive, but fanciful and, as such, the subject matter of valid trademarks.

"It is unnecessary to determine many questions sought to be raised, among others, whether the proceeding is in the public interest, in the light of the fact that petitioner does less than 1 percent of the mattress and cushion business of the country, that hundreds of competitors use similar advertising pictures, that petitioner and its predecessors have established a high reputation and have always fulfilled their guarantee to make good any complaints, or to what extent the use of otherwise valid trademarks in unfair competition may be forbidden. The determination of validity or invalidity of the picture as a trademark, because fanciful or merely descriptive, is not within the jurisdiction of the Commission or of this court in this proceeding. The sole inquiry here is that of unfair competition against the public interest.

"In our judgment, this pictorial representation of the process of manufacturing Ostermoor mattresses and of the materials used therein, even though exaggerated as to their characteristics, cannot deceive the average purchaser and the record is practically bare of any evidence of actual reliance upon the puffing exaggeration of qualities. There is no basis for the finding that 'substantial numbers of purchasers had been misled and deceived by the grossly exaggerated pictorial representation.'

"Finding no evidence of unfair competition, the order of the Commission is annulled."

The picture on the Ostermoor trademark, incidentally, is public property, the Court of Appeals of the District of Columbia having so held several months ago.

Old Claims in New Applications

CAN one take an element of this patented invention, an element of that and an element of a third, put them all together and get a new patent on the new aggregation?

No, unless, of course, the various features work in a new way in the contrivance. The mere fact that the device will accomplish better results than devices which went before will not justify the issuance of a patent.

So Lewis Fine has discovered, whose application for a patent on a vehicle wheel construction has been denied an appeal by the Patent Commissioner. In refusing a patent the Commissioner says:

"The applicant has submitted, in connection with his brief, a showing of how the various strains to which a construction of this character is subjected in use are resisted. The fact is noted by applicant that all his features are not bound in a single anticipating structure and that, in consequence, each of the devices of the prior art is open to some objection.

"It may be said that the applicant has done no more than pick out from three patents, two to Putnam and one to Simmons, the three features which appealed to him as possessing the greatest merit and uniting them in ju

Patents Recently Issued

Classified Advertising

Advertisements in this section listed under proper classifications, rate 25c per word each insertion; minimum number of words per insertion 24, maximum 60. Payments must accompany each insertion.

Official copies of any patents listed in this section at 15c each; state patent number to insure receipt of desired patent copy.

Pertaining to Aeronautics

PROPELLER.—For airplanes, rotated by means of the reactions effected by passing a fluid medium through the blades, or by the use of an internal combustion motor. Patent 1626424. W. W. Paget, 3121 Bayo Vista Ave., Alameda, Calif.

AIRPLANE LAUNCHING AND LANDING APPARATUS.—Including a platform which is capable of elevation to an appropriate height for facilitating the launching and landing of aircraft in restricted places. Patent 1625,020. F. G. Diago, Box 1972, Habana, Cuba.

AIRCRAFT.—Having lifting apparatus which causes the craft to ascend after the manner of a helicopter, and a second means for causing the translatory movement of the craft. Patent 1625646. F. Geddis, c/o Mrs. C. Groves, 271 5th Ave., Brooklyn, N. Y.

Pertaining to Apparel

COMBINED CORSET AND BRASSIERE.—The parts so connected as to present a substantially uniform appearing garment, each garment functioning independently, the corset acting to hold down the brassiere. Patent 1625664. J. J. Kispert, c/o I. Newman & Sons, 17 Oak St., New Haven, Conn.

METHOD OF PRODUCING APPAREL ORNAMENTS.—Such as frogs and like garment fastening having a plurality of loops formed from a continuous strip without crossing of the corded braid. Patent 1624805. A. Rosenberg, 152 E. 3rd St., Brooklyn, N. Y.

GARMENT ATTACHMENT.—Adapted for use with wearing apparel, for removably securing a fountain pen or the like, within a pocket, by means of a resilient clip. Patent 1621826. P. T. Burtchaell, 680 4th St., San Rafael, Calif.

CORSET.—Partly made of elastic material, and particularly cut to provide means for preventing the upper front portion projecting away from the body. Patent 1623081. Blanche Carvelli, 311 Pacific Bldg., San Francisco, Calif.

REMOVABLE HALF-SOLE FOR SHOES.—With clamping means adapted to be snugly fitted over the edge of a permanent sole which will look and wear as an ordinary half-sole. Patent 1627465. A. S. Simko, 92 3rd St., Passaic, N. J.

Chemical Processes

PAINT COMPOSITION.—For coating walls of brick, stone or concrete, and for protecting timbers of any kind. The composition con-

way they have been used before in a single wheel.

"There is not believed to be any new or combined result present but merely the aggregate results that were obtained in the old structures.

"While applicant objects to the citation of three patents against his claim, I am aware of no adjudicated case which limits the number of references that may be presented to anticipate a claim. Indeed, the selection of old devices from the prior art and the placing of them in a single or unitary structure may, in a given case, go on indefinitely without the production of anything patentable.

"It would seem the applicant in his construction has not combined the parts heretofore found in separate patents but has merely used them as separate parts of his device to accomplish the functions in the way revealed by the prior art.

"As to the claims copied from the patents, it is not believed any error has been made in the holding that applicant is not entitled to make them."

You Cannot Patent a Function

YOU may obtain a patent for a machine, but not for the machine's functions. This well-settled but often misunderstood principle of patent law is illustrated by the decision of the Examiners-in-Chief in denying the application of Green Carlton Hosch, whose improved shutter for a measuring machine chart already had been issued. An appeal was taken from the rejection of some of the claims. Quoting a prior decision by the Commissioner, the Board says:

"It is well-settled law that a patent cannot issue for a result sought to be accomplished by the inventor of a machine, but only for the mechanical means or instrumentalities by which that result is to be obtained. One cannot describe a machine which will perform a certain function, and then claim the function itself and all other machines that may be invented by others to perform the same function."

A Complete Trade Reversal

IN one respect, at least, the United States has lost its trade balance in the last 20 years. Two decades ago we were an important exporter of forest products; now we have become a preponderant *importer* of lumber, pulp wood and associated materials.

Our total forest-products exports in 1906, with the exception of furniture and containers holding other merchandise, were 2,640,000,000 board feet; our imports of wood products were the equivalent of 1,651,000,000 board feet, leaving an excess of exports for that year of 989,000,000 board feet.

Last year, according to the Department of Commerce, our trade was completely reversed. Our exports amounted to 3,623,000,000 board feet, against imports of wood products equivalent to 6,689,000,000, thus registering an import balance of 3,623,000,000 board feet.

Round Ends for Neckties

THE Franklin Knitting Mills, Inc., are entitled to a monopoly in knitted neckties with round ends, according to a recent decision by the United States Supreme Court denying a petition for a writ of review by the Gropper Knitting Mills, Inc. The Franklin company had won its suit for infringement of its design patent for an "ornamental design for a knitted necktie" which tends to prevent the end of the tie from becoming unraveled.

Originally the suit was dismissed by the District Court for Southern New York, on the ground that the patent was invalid for lack of novelty and invention. The Circuit Court, in reversing this decision, held that in a design patent it is immaterial if the design is hidden from the eye of the wearer. It was on the claim that a design must be visible that the Gropper Mills sought a review of the decision.

The Patented Bouillon Cube

DID it ever occur to you that a little bouillon cube is a patented article? Not only has it been patented, but the Federal District Court for Southern New York recently has held that the patent owned by the American Kitchen Products Company is infringed by cubes of meat and vegetables manufactured by Steck and Steck.

"The great number of prior patents disclose that those schooled in the art had been seeking in vain to effect what the inventor finally accomplished," says Judge Bondy, in writing the opinion of the court. "The cubic unit rations at once became commercially popular and apparently supplies a larger demand. Four million cubes have been made and sold by the plaintiff since 1909 and royalties amounting to a very substantial sum have been paid or credited to the inventor under the patent in suit. The defendant urges the lack of invention in view of prior disclosures. None of these, however, discloses the same ingredients, the same process and the same product as plaintiff's.

"In reply to a letter written by the plaintiff, January 12, 1912, giving notice of the infringement of plaintiff's patent, defendant's attorneys did not deny infringement but stated that they doubted the validity of the patent.

"In 1914 the plaintiff brought suit against a most resourceful infringer. Its prosecution was delayed because it was impossible to get the testimony of necessary witnesses in Germany during the war. On May 3, 1921, a decree in that suit was entered on consent, sustaining the patent and holding it infringed.

"On July 22, 1921, another suit was brought against another infringer who likewise consented, October 5, 1922, to a decree sustaining the patent and holding it infringed.

"On February 14, 1924, suit was brought against the defendant. There is no proof that defendant changed its position or was prejudiced in any way by reason of the delay in bringing suit against it. Under the circumstances, the court cannot find that plaintiff was guilty of such laches in delaying to bring action against the defendant as to deny it protection.

"There is no evidence that the defendant did use the ingredients specified in the patent in suit substantially in the way described in the patent, and that the product sold by it was the same as plaintiff's product."

prises 80% filler, 10% calcium sulphate, and 10% sodium silicate. Patent 1625815. J. W. Lowman, c/o J. Rink, Lafayette, Ga.

PROCESS FOR THE PREPARATION OF CUCURBOCITRIN.—A drug produced from the seed of "Cucurbita Citrellus" or watermelon, the product being efficacious for the reduction of high blood pressure. Patent 1626321. I. S. Barksdale, c/o Health Dept., Greenville, S. C.

TOBACCO WAX AND PROCESS FOR PRODUCING THE SAME.—Which comprises bleaching the tobacco in water at a temperature below 212°, F., for 48 hours; the substance extracted is fire-proof and usable as an insulation. Patent 1624155. S. Amster, Red House, Ky.

PROCESS OF AND APPARATUS FOR CONDENSING, TREATING AND WASHING HYDRO-CARBON VAPORS.—Apparatus for condensing, treating and washing hydro-carbon vapors, in which water is given a whirling movement and the vapors introduced thereinto. Patent 1627431. C. L. Freeland, Bristow, Okla.

Designs

DESIGNS FOR WOVEN FABRIC.—Patent 72-487. E. Meyer, 39 Worth St., New York, N. Y.

DESIGN FOR A DRESS.—Patent 72501. M. Siegel, c/o Franklin Simon & Co., 38th St. and 5th Ave., New York, N. Y.

DESIGN FOR A BELT FOR PERSONAL WEAR.—Patent 72432. I. Leibovitz, c/o S. & L. Belt Co., 105 Wooster St., New York, N. Y.

DESIGN FOR A COMBINED BATHROOM FIXTURE.—The inventor has been granted two patents, 72543 and 72544. J. H. Balmer, 259 Plane St., Newark, N. J.

DESIGN FOR A DRESS.—Patent 72531. M. Siegel, c/o Franklin Simon & Co., 38th St. and 5th Ave., New York, N. Y.

DESIGN FOR A STOCKING.—Patent 72365. R. F. Friedrich, c/o Weber & Friedrich Co., 16th St. and Hunting Park Ave., Philadelphia, Pa.

DESIGN FOR A PRINTED FABRIC.—Patent 72378. J. H. Mack, c/o N. Lowenstein & Sons, 40 W. 23rd St., New York, N. Y.

Electrical Devices

LOW-CAPACITY FUSE.—In which the fuse wires are connected in a manner to provide good electrical connection, effecting a quick break when the fuse operates. Patent 1626105. E. V. Sundt, 4527 N. Ashland Ave., Chicago, Ill.

ELECTRIC SWITCH.—A combined clock and switch, which will automatically close the electric circuit of an automobile parking light at a predetermined time. Patent 1624120. J. E. Springer and R. A. Harry, 2837 Pressbary St., Baltimore, Md.

FLASH LIGHT.—Which employs a generating means operable by a spring motor, controlling the speed within defined limits for increasing or decreasing the intensity of the light. Patent 1624686. R. J. Smith, c/o The Bat-Les Lite Co., 8 Hubbert St., Albany, N. Y.

FUSE PLUG AND RECEPTACLE.—Constructed to preclude the introduction of a metal conductor such as a penny, or metal strip, between the lower and central contracts of the plug receptacle. Patent 1624030. R. H. Williams, c/o United Electric Co., 314 Fulton Ave., Evansville, Ind.

COMBINATION TERMINAL.—For electrodes of electric apparatus, whereby a spring terminal may be readily mounted on a carbon stick and held firmly in operative position. Patent 1627447. J. J. Mucher, 285 North 6th St., Brooklyn, N. Y.

RHEOSTAT.—Wherein mercury or other

current conductive liquid serves as a current connecting medium between a resistance coil and a conductor. Patent 1625763. E. H. Bobo, 431 Bobo Ave., Ranger, Texas.

Of Interest to Farmers

CALF-WEANER.—Provided with means consisting of flaps inclined at an angle, readily inserted in the calf's nose, and fastened in place without harming the calf. Patent 1626090. G. M. Krauss, Rock Eagle Route, Lingle, Wyoming.

GARDEN CULTIVATOR.—In which the ground-digging tools are disposed in two sets, controlled by the left hand, and right hand, of the operator or operated simultaneously. Patent 1625839. S. W. Shaw, Galesburg, Kans.

IRRIGATING HYDRANT.—For farm irrigation, adapted to supply and control streams of water to any desired number of field furrows. Easily taken apart for cleaning. Patent 1624817. C. E. Crownover, 549 Ladd Ave., Portland, Ore.

EVAPORATION METER.—Designed for use in incubators, using an ordinary test tube in a holder upon which the scale is so inscribed that it may be easily read. Patent 1625310. R. L. Gilles, c/o Evapometer Co., Fargo, N. D.

MOISTURE GUIDE FOR INCUBATORS.—Which serves to provide the operator with a direct and accurate reading, showing the rate and amount of evaporation actually occurring. Patent 1625420. C. T. Patterson, c/o The Moisture Guide Co., Springfield, Missouri.

GRAIN WASHING AND DRYING MACHINE.—Wherein the grain is thoroughly washed, polished, aerated, tempered and dried, so as to be properly conditioned for milling purposes, without breaking the grain. Patent 1624831. D. Geddes, c/o Ingeneiro de Molinos Harineros, Guadalajara, Jalisco, Mex.

SPADING DEVICE.—Adapted to dig into the ordinary earth with due pressure, but when striking a stone or obstruction, the spade will be released to prevent its breaking. Patent 1624610. O. A. Matson, 5351 N. Paulina St., Chicago, Ill.

Of General Interest

VANITY-CASE-COMPACT HOLDER AND CATCH.—Wherein the holder may be formed as a solid or divided ring, with bent portions presenting a corrugated surface for gripping a compact. Patent 1626413. W. G. Kendall, 118 Market St., Newark, N. J.

WINDOW CLEANING DEVICE.—Especially adapted for cleaning outside surfaces of window panes, one type being used for the washing operation and a second type for drying the surface. Patent 1628593. M. Hayes, 180 Sterling Place, Brooklyn, N. Y.

MARKING DEVICE.—Which enables the operator while wearing a skirt to evenly mark on the same a line indicating a predetermined distance from the floor. Patent 1626440. R. Wasserman, 57 W. 124th St., New York, N. Y.

BATH MIT.—Constructed for bath and shampoo use; having two compartments with a hose connection for a constant supply of water. Patent 1619180. A Benussi, 445 Lafayette Ave., Brooklyn, N. Y.

FLUSHING TANK.—Which is extremely quiet in its operation, especially designed for places where water pressure is low; may be installed after the tank is set. Patent 1625311. N. J. Gondolf, 703 State St., New Orleans, La.

ATTACHMENT FOR BEVERAGE MIXERS.—Having means for modifying, when required, the temperature of a beverage either preparatory, subsequently or during the mixing operation. Patent 1623535. C. Ferguson, c/o Marine Hospital No. 43, Ellis Island, N. Y.

DISPLAY EASEL AND TRAY.—With clamps adapted to support articles, such as cutlery, and pictorial representations indicating the particular piece of cutlery to be placed therein, from the tray. Patent 1625647. G. C. Gillan, c/o The Ontario Knife Co., Franklinville, N. Y.

PACKING FOR GATE VALVES.—Such as are used in connection with water and gas mains, which will be practically self-packing, and will facilitate in the making of repairs. Patent 1625698. W. H. Barton, 30 Park St., Montclair, N. J.

CANOPY HOLDER.—Of the collapsible type, which may be conveniently transported in very small space, and easily placed in operative position to support a mosquito netting. Patent 1625673. V. P. Nelson, 264 Lexington Ave., New York, N. Y.

SEDIMENT TRAP FOR BOILERS.—Which may be readily attached to new or old domestic boilers, allowing the sediment to be trapped in a storage chamber and readily removed. Patent 1625709. F. Conrad, 109 Elm Ave., Bogota, N. J.

CONTAINER.—Provided with a mounting and hanger to be positioned at a convenient height for supporting a glass container, so that liquids may be readily dispensed therefrom. Patent 1624830. R. F. Emsley, 4228 Wooster Road, Rockey River, Ohio.

PNEUMATIC PAD.—Particularly designed as a saddle pad, collar pad or the like, functioning to afford a cushion between the harness and the animal, to ease strain. Patent 1624807. J. A. Schinner, P. O. Box 222, Greenville, Ohio.

TABLE.—Carried by a single standard or pedestal, and provided with means for adjusting the top to insure its positioning in a horizontal plane. Patent 1624770. R. J. Stuart, c/o Clarence J. Drake, Market and Cannon St., Poughkeepsie, N. Y.

METHOD OF FILLING TREE CAVITIES AND THE FILLING ITSELF.—Which will fit tightly against the walls of the cavity, be proof against destructive insects, and provide an affinity to the characteristics of the tree in its natural expansion and contraction. Patent 1624820. G. Van Yahres, Rutland St., Westbury, L. I., N. Y.

COMBINED COVER AND STRAINER.—Having means whereby it may be readily associated with or disassociated from a utensil, and adapted for use with utensils of various sizes. Patent 1624745. F. W. Kuhnast, 1537 St. Lawrence Ave., Bronx, N. Y.

NURSING-BOTTLE HOLDER.—For supporting a bottle from a carriage, bassinet, or the like, whereby the same may be readily shifted to various positions, and eliminates manual holding. Patent 1624695. A. Tufenkjian, 1873 Boulevard, West New York, N. J.

POLISHING COMPOSITION.—Comprising finely divided zinc dust, pumice and oil, especially adapted for polishing and graining metal surfaces, and photo-engravers' plates. Patent 1624733. A. B. Fisher, 16 Steuben St., Brooklyn, N. Y.

LOOSE-POWDER CONTAINER.—In which the powder is held about a central opening and directed thereto by the depression of a diaphragm normally closing the opening. Patent 1624874. S. S. Radley, c/o Evans Case Co., No. Attleboro, Mass.

GYROSCOPIC STABILIZER.—Employed in conjunction with the mountings of instruments, such as headlights, searchlights, cameras, or the like, for holding them relatively stationary. Patent 1621815. C. E. Schueller, 903 Ordway St., Berkeley, Calif.

WINDOW-SASH ATTACHMENT.—In the form of bars running through guide means on the lower sash, whereby the upper window may be raised and lowered within convenient reach. Patent 1620617. H. Huyard, 248 Whitney St., San Francisco, Calif.

HAIR-WAVE COMB.—Having hair-engaging members which co-act to produce a novel arrangement of waves, the strands being grouped in piles. Patent 1624757. G. B. O'Connor, 691 Bergen Ave., Bronx, N. Y.

HEADGATE.—Adapted to effectively control the passage of water to the mains and laterals of an irrigation system, and firmly held to prevent displacement. Patent 1621,748. W. Murdock, Deeth, Nevada.

DISPENSING CABINET.—In which the displays are so placed that the comparatively old supply will be presented for vending ahead of the latest supplies. Patent 1621,971. R. C. Curtis, Box 184, Martinez, Calif.

HAIR WAVER.—Whereby a double wave in the hair can be very readily produced, which gives a perfectly flat marcel wave effect, in a minimum of time. Patent 1618144. M. Banach, c/o Raven Beauty Shop, 2664 Grand Concourse, Bronx, N. Y.

RECEPTACLE.—Which can be stamped out of sheet metal, the edges being formed into a bead free from recesses or roughness, thus rendering the device sanitary. Patent 1624,273. D. C. Murphy, Box 626, Scobey, Mont.

HAM PRESSER.—Whereby a piece of ham may be conveniently inserted into a two-part container and compressed for subsequent cooking, the container and press being easily disconnected. Patent 1624808. G. W. Scholten, 708 Linn St., Muscatine, Iowa.

DOLL HEAD.—Having a series of tufts, simulating hair around the head, which in combination with the surface ornamentation, give the impression of a pickaninny. Patent 1627511. R. A. Hope, c/o Averile Mfg. Co., 143rd St. and Wales Ave., New York, N. Y.

BIRD PERCH.—Easily placed in position against a support, and easily removed for cleaning; constructed with smooth surface, preventing injury to the bird or his feathers. Patent 1627448. C. W. Mueller, 1089 Summit Ave., Jersey City, N. J.

MEANS OF FIXING ARTIFICIAL HAIR DRESS ON NATURAL HAIR.—Which may be used in dressing either long or short hair, consisting essentially of a wire spiral, of thin steel, of low pitch and short diameter. Patent 1627469. E. Syptroth, c/o Gustave Sattler, 12 W. 50th St., New York, N. Y.

METHOD OF SAND-BLAST RELIEF-CARVING.—Whereby flowers or other configurations may be carved on stone by sand-blast to produce a substantially life-like appearance in relief. Patent 1627456. G. R. Philip, c/o Cross Bros. Co., Northfield, Vt.

LINE-DRYING ATTACHMENT FOR FISHING RODS.—Which may be easily attached to a rod for drying the line as it is reeled in, thus preventing water dropping on the hands or clothes. Patent 1627514. L. Kraemer, 6 Hancock Rd., Homefield, Yonkers, N. Y.

CIGARETTE HOLDER.—Capable of being supported on a finger of the hand, permitting the free use of the other fingers without discoloring the fingers. Patent 1627463. M. J. Russak, 7038 Link Court, Maspeth, N. Y.

COLLAPSIBLE TENT SUPPORT.—For the ordinary form of three pole tent, including a pair of uprights, and ridge pole occupying a minimum amount of space when not in use. Patent 1627546. W. S. Ryerson, Edmonds, Wash.

HAND BAG.—Of the envelope type, so constructed that there is no danger of losing small articles no matter how carried, provided the flap is in closed position. Patent 1627496. E. Elias, 38 W. 32nd St., New York, N. Y.

GAS-MAIN STOPPER.—An assemblage comprising a collapsible frame having a diaphragm, adapted to be passed through an opening in the main and then expanded. Patent 1627502. P. Goodman, 528 Atlantic Ave., Brooklyn, N. Y.

STEAM TRAP.—Wherein the water is continuously discharged from the trap without danger of steam escaping. Patent 1627271. F. A. Burrows, c/o F. A. Burrows Mfg. Co., York, Pa.

RAZOR CASE.—For use with various styles and sizes of razors, and is adapted to oil and condition the blades when they are not in use. Patent 1615396. C. D. Lorenz, 616 Mills Bldg., El Paso, Texas.

Hardware and Tools

ELLIPSOGRAPH.—By means of which ellipses and ovals of various sizes and proportions can be drawn or inscribed in an accurate manner. Patent 1626430. A. C. Sanders, c/o Quality Engraving Co., 12 W. 9th St., Erie, Pa.

COMBINATION LEVEL.—Wherein two level elements are used, to act at various times as a line level, a surface level, and as an angle finder. Patent 1624684. E. W. Smith, 241 E. 25th St., New York, N. Y.

COMBINATION LOCK.—Which may be readily applied and readily opened by one familiar with the combination, particularly applicable as a chain lock. Patent 1627462. F. D. Rohmer, 401 Valley St., Lewistown, Pa.

TOOL.—With means whereby it can be used for several purposes, such as a cold chisel, an ordinary wrench, a spanner wrench, or for engaging nuts. Patent 1627,-435. J. A. Hooben, 349 Bay St., Taunton, Mass.

STATIONARY-WASHTUB COVER FOLDING DEVICE.—A flexible element anchored to the wall, having a hooked member for retaining the cover of a washtub in raised position when in use. Patent 1627476. J. H. Barrett, 312 E. 93rd St., New York, N. Y.

Heating and Lighting

OIL BURNER.—Comprising a vaporizing apparatus partly filled with oil, and heated, and means for discharging compressed air against the oil vapors which pass through orifices for ignition. Patent 1622797. F. McCloskey, Box 562, Colorado Springs, Colo.

WATER HEATER.—In which the water circulates through an inner tube and backwardly through an outer tube, the latter being disposed at the hottest part of a combustion chamber. Patent 1625286. D. J. Shaffer, 286 Fox St., Aurora, Ill.

SIGN.—Particularly adapted for use on highways and at intersections of roads, mounted on a post and having a plurality of illuminated sides. Patent 1627437. A. H. Humphrey, Box 54, Salem, N. Y.

Machines and Mechanical Devices

VENDING MACHINE.—The arrangement being that a package is vended after each insertion of a coin, the coin shifting a locking mechanism as the device is rotated. Patent 1626429. J. Ruoff, c/o Hampton Novelty Co., 83 Worth St., New York, N. Y.

LUBRICATING APPARATUS.—Functioning as a grease cup, which may be entirely manual in its operation or semi-automatic. The device is simple in construction. Patent 1626478. W. R. E. Nohse, 144 E. 17th St., New York, N. Y.

COLLAPSING OIL DRILL.—For well drilling, which with its associated parts will drill a straight hole and effectively flush the hole with a hydraulic jet while drilling. Patent 1625247. B. J. and E. R. Dudley, 797 Highland Ave., Piedmont, Calif.

PORTABLE HONING OR LAPPING MACHINE.—Whereby the cylinders of any standard automobile engine may be expeditiously lapped without removal of the engine from the chassis. Patent 1624636. H. Strand, 1827 E. 112th St., Cleveland, Ohio.

THREAD TIGHTENER.—Adapted for use with buttonhole-sewing machines having automatic thread cutters in which the shears, after cutting, are swung sidewise out of the cloth pressure apparatus. Patent 1624898. A. Hennig, c/o Messrs. Fehlert, Loubier, Harmsen and Buttner, S. W. 61 Belle-Alliance-platz 17, Berlin, Germany.

CONCRETE, MORTAR AND PLASTER MIXER.—Including an oscillatory drum in which are provided staggered grate rods and vanes adjacent the walls, which will result in a stronger mixture with less manual effort. Patent 1624705. G. W. Adams, 807 Builders Exchange Bldg., San Antonio, Tex.

FOUR-CYLINDER DRAWHEAD. — For high draft with special weighting of the top rollers situate in front and behind the pair of drawing rollers. Patent 1624815. E. Toenniessen, c/o A. Elliot, 246 Friedrick Strasse, Berlin S. W. 48, Germany.

HOISTING-ENGINE CONTROL.—Which automatically shuts off the hoisting engine power and applies a brake mechanism when the skip or cage in a mine shaft exceeds a predetermined speed at either of its limits of travel, and an electrically actuated signal for informing the operator. The inventors have been granted two patents, 1624260 and 1624261. J. W. Lilly and H. H. Logan, c/o H. H. Logan, Duro Metal Products Co., 2649 N. Kildare Ave., Chicago, Ill.

TORCH MECHANISM FOR WELDING MACHINES.—Adapted to be introduced between two elements disposed in confronting relation, supported torch elements heating the confronting elements. Patent 1623503. C. L. Stancliff, 1005 Oregon St., East Bakersfield, Calif.

LAMINATED PACKING AND METHOD OF FORMING THE SAME.—As utilized in packing cups for pistons or plungers, avoiding the crinkling, stretching and ravelling of threads on the finished product. Patent 1625508. R. H. Thorne, Williamsport, Pa.

OIL WELL PUMP.—Which eliminates the possibility of sand settling upon and scoring the outer periphery of the stationary plunger, and provide an unobstructed discharge. Patent 1625230. C. B. Thurston, Box 222, Oildale, Calif.

VIENNA-ROLL-FORMING MACHINE.—Wherein means are provided for rapidly feeding dough to the forming device, forming the dough in desired manner, and then ejecting the prepared roll. Patent 1625649. C. Gottfried, 538 E. 72nd St., New York, N. Y.

LIQUID-MIXING APPARATUS.—For the general mixing of two liquids, but particularly for mixing milk of lime with sugar juices, in a raw sugar plant. Patent 1625592. E. T. Conant and L. S. McLane, Honomu, Territory of Hawaii.

BAILER DUMP.—For use in sinking deep oil wells, in which bailing and dumping operations may be optionally carried out by a device associated with the valve dart. Patent 1625686. S. A. Rutner, 84 Amsterdam Ave., New York, N. Y.

SAFETY FEED MEANS.—Which may be readily applied to washing machine wringers to cause an article to be fed to the rollers without injury to the hands. Patent 1627-491. W. Doellnes, 743 Bergen Ave, Jersey City, N. J.

APPARATUS FOR VACUUMIZING and SEALING CANS.—The machine operates to puncture the sealed cover, withdraw the air from the can and seal the opening with solder, ready for shipment. Patent 1626291. A. E. Lindstrom, 17 Tehama St., San Francisco, Calif.

METHOD AND APPARATUS FOR MAKING COMPOSITE MOTION PICTURES.—By the use of a pair of objectives of different focus and a mirror or a miror silhouette. Patent 1627,-295. E. Schufftan, Kaiser Allee 79a, Friedenan, Berlin, Germany.

PLUNGER PUMP.—Especially suitable for use in pumping chemical sprays for fruit trees, etc. Will stand heavy duty and continuous operation. Patent 162299. F. T. Costello, Box 487, Vacaville, Calif.

Prime Motors and Their Accessories

OIL REFINER FOR INTERNAL COMBUSTION ENGINES.—May be readily attached to a standard engine, and has means for heating the oil that it may more readily flow through the filter. Patent 1624957. C. E. Lilley, 5320 Brookside Blvd., Kansas City, Miss.

MOTOR.—Of the multi-cylinder type wherein the piston rods operate cams carried by oppositely disposed shafts, a rotary movement being imparted on the downward movement of the pistons. Patent 1624269. P. Marchetti, 735 Montgomery St., San Francisco, Calif.

MOTIVE-FLUID GENERATOR.—A heat generator and engine, both being so combined as to constitute an engine unit, resulting in a rigid economy of fuel. Patent 1624464. M. E. Bigelow, 1356 So. 6th E. St., Salt Lake City, Utah.

Medical and Surgical Devices

SURGICAL APPLIANCES.—Which will not only hold the tissues of a wound, but will tie a ligature on the tissue, the operation being performed with one hand. Patent 1625602. H. G. Gould and K. D. Obenshain, c/o H. G. Gould, McKinney, Tex.

OBSTETRICAL INSTRUMENT.—For use by veterinarians in facilitating the birth of animals, particularly pigs, insuring immediate delivery without danger, or injury, or undue suffering. Patent 1626149. E. O'Dell, Central City, Neb.

Musical Devices

REED HOLDER.—A comparatively stiff structure with flexible means for holding saxophone reeds against accidental injury by twisting or bending when carried in a pocket. Patent 1625651. F. Gretsch, c/o The Gretsch Mfg. Co., 60 Broadway, New York, N. Y.

Railroad and Their Accessories

RAILWAY-TRACK CONSTRUCTION.—Including means for supporting rails in special relation so that they are securely held against spreading, sinking or other movement, without the use of wooden ties. Patent 1625288. R. L. Spencer, Greenfield, Ark.

REVERSING GEAR FOR LOCOMOTIVES.—Adapted to be connected with the reach rod of a locomotive, and can be operated manually with ease, but prevents accidental retrograde movement. Patent 1625364. J. B. Holland, 923 Hollins St., Baltimore, Md.

RAILROAD SWITCH.—With means for facilitating the throwing of the switch points to either of their set positions and maintaining them firmly although yieldingly. Patent 1626752. B. H. Patrick, Box 82 Mount Gay, W. Va.

Pertaining to Recreation

RACKET STRING.—Formed by binding the strands of twisted gut with fine wire, preventing material swelling, and providing a wearing surface beyond the outer surface of the gut. Patent 1624720. A. M. Dritz, 258 5th Ave., New York, N. Y.

TARGET GAME.—An apparatus having a figure simulating a baseball player with a bat, the bat carrying target elements which are to be struck by thrown balls. Patent 1624765. W. C. Schmeh, Main St., Park Ridge, N. J.

INDEX TO ADVERTISERS

SCIENTIFIC AMERICAN—JULY, 1927

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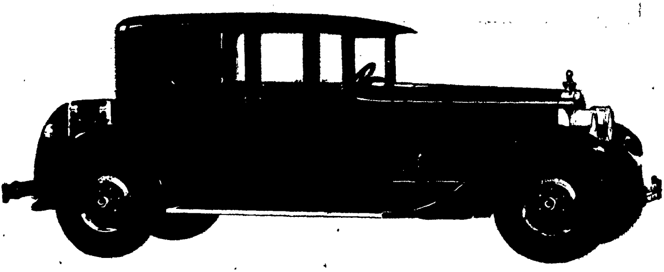
"The supreme combination of all that is fine in motor cars"



Color, Nature abounds in beautiful and harmonious color combinations. The birds, the flowers, the sunset skies, set perfect examples—and point the way to brilliant color schemes all in perfect taste.

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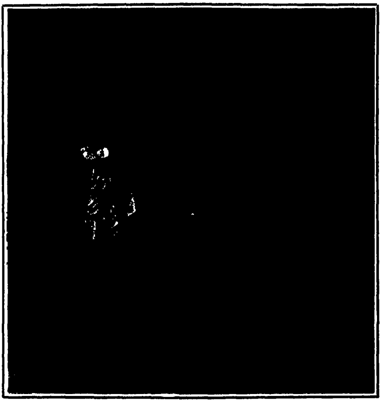
AUGUST 1927 *Thirty-five Cents a Copy*



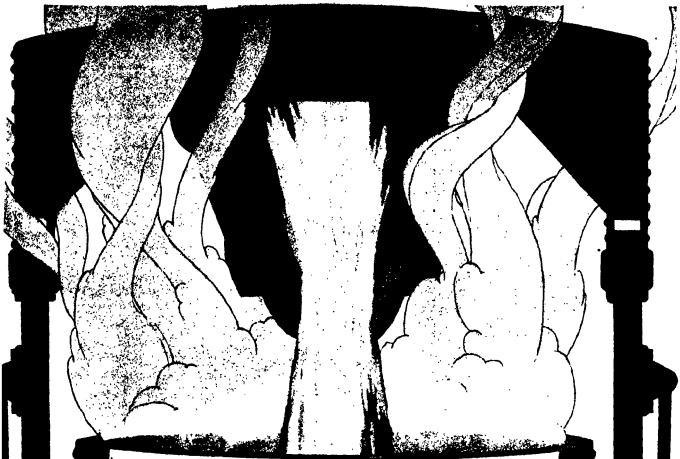
ARE ATHLETES MACHINES?

BY DR. A. V. HILL

NEW GOLF CLUB DESIGNS

SOCIAL INTELLIGENCE

Scientific American August 1927 Vol 137 No. 2 Entered at New York, N Y Post Office as Second Class Matter June 28th 1879, under the Act of March 3rd, 1879, additional entry at Dunellen, N J Published Monthly by Scientific American Publishing Co 24 West 40th Street New York City. Subscription Price $4 00 per year



SCIENTIFIC AMERICAN

August 1927 | *Edited by* ORSON D. MUNN | Eighty-third Year

Transmutation

ONCE more have the SCIENTIFIC AMERICAN'S transmutation experiments been confirmed. Dr. L. Thomason of the California Institute of Technology has just duplicated the methods employed by Smits and Karssen, two Dutch physicists who believed, nearly two years ago, that they had successfully transmuted lead into mercury. No results.

Last February Dr. M. W. Garrett, an English scientist, reported to the Royal Society that his attempt to transmute tin into indium by the same method was a failure.

A few months ago the noted German chemist, Dr. Fritz Paneth, came to the conclusion that his apparent former success in transmuting hydrogen into helium was without question a mistake, the trace of helium found having come from the glass vessel itself.

Two years ago Prof. Sheldon, Corresponding Editor of the SCIENTIFIC AMERICAN, conducted for this journal a duplication of the famous original transmutation experiment of the German, Prof. Miethe. No result.

Quite naturally we are pleased every time someone else confirms the SCIENTIFIC AMERICAN tests. Evidently the atom is having the last laugh.

Elephants

WANTED: An American elephant, twelve feet or more high and with curved tusks eight to twelve feet long. Has been seen in many states, but probably not since the glacial period. Went by the name of "mammoth" and was a poor relative of the well-known mastodon family. Anyone having news of his whereabouts kindly communicate with the officials of the United States National Museum, Washington, D. C.

Unless the National Museum can find an American elephant in one piece, it plans to assemble one from tusks found in one place, a backbone 2000 miles distant in another, and four legs found in four other places. Such a conglomerate skeleton is being assembled now, but the skull and pelvis are still missing. In the absence of a complete framework a skull and a pelvis will be gratefully received.

Thanks

Gratifying indeed has been the response of our readers to the new form of the SCIENTIFIC AMERICAN. Many of them have written to us, telling why and how much they like the change. We are answering all of these letters as fast as possible, but in the meantime, we want to take this space to thank all of those who have written to us, but have not as yet been answered. Up to date we have received only one adverse comment. We would greatly appreciate hearing from the rest of you, giving your criticisms as freely as your praise.

CONTENTS

AUGUST 1927

DEPARTMENTS

Health

ULTRA-VIOLET radiation is beginning lately to come in for quite a lot of popular attention. It is getting into the newspapers, which means that a lot of people are going to be badly misled about its nature and uses. Several kinds of special glass and other materials which will transmit ultra-violet radiation of health giving value (ordinary window glass will not) have been put on the market and advertised, and are beginning to be used in hospitals—occasionally even in homes.

What will ultra-violet radiation cure? Can the layman obtain an ultra-violet radiation lamp and use it himself for home treatment? Are the "violet ray" outfits sold at some drug stores any good? (Answer: No). Exactly what is ultra-violet radiation, anyway?

One of our sub-editors says he has heard so much nonsense and hocus pocus about this subject during the past few months that he is getting mad, and may inflict on our readers a series of articles about it. Can you stand it?

Islets

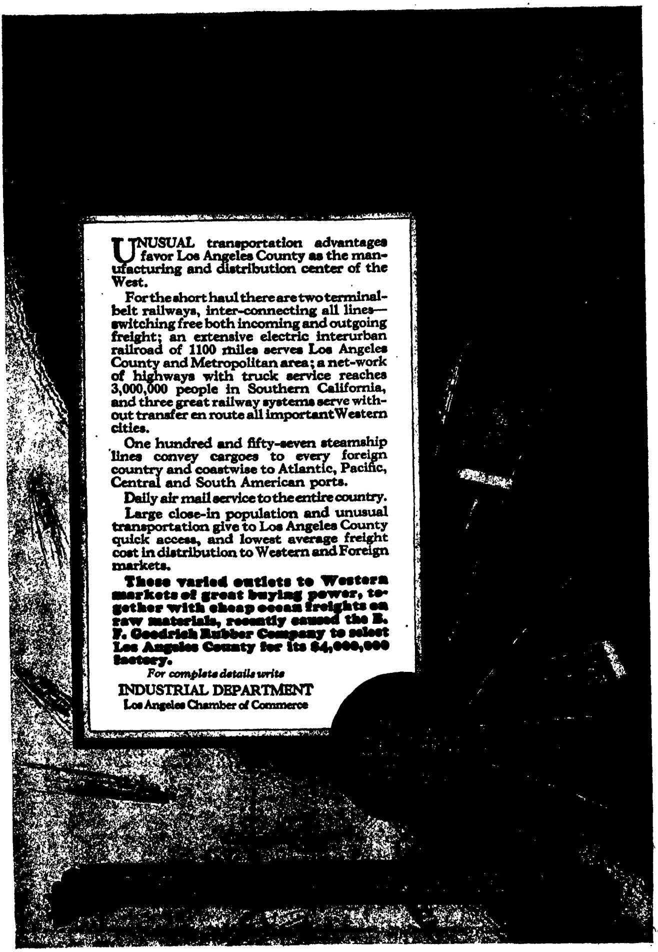
HOW many Hawaiian Islands are there? You probably could not guess within five of the correct number. The SCIENTIFIC AMERICAN does not know the answer; even the United States Government, which owns the Hawaiian Archipelago, is unable to tell you.

The Coast and Geodetic Survey would like to know, however, and a report soon will be made showing what additional work will be necessary to place all the islands on the charts. The uncharted ones are small and lie to the westward of the main Hawaiian group.

The world is a pretty big place yet, even though science has been making it smaller every year.

Cover

OUR cover illustration this month, painted for the SCIENTIFIC AMERICAN by Howard V. Brown, depicts the unusual cable-painting method which is described in complete detail on page 113.


UNUSUAL transportation advantages favor Los Angeles County as the manufacturing and distribution center of the West.
For the short haul there are two terminal-belt railways, inter-connecting all lines—switching free both incoming and outgoing freight; an extensive electric interurban railroad of 1100 miles serves Los Angeles County and Metropolitan area; a net-work of highways with truck service reaches 3,000,000 people in Southern California, and three great railway systems serve without transfer en route all important Western cities.
One hundred and fifty-seven steamship lines convey cargoes to every foreign country and coastwise to Atlantic, Pacific, Central and South American ports.
Daily air mail service to the entire country.
Large close-in population and unusual transportation give to Los Angeles County quick access, and lowest average freight cost in distribution to Western and Foreign markets.
These varied outlets to Western markets of great buying power, together with cheap ocean freights on raw materials, recently caused the B. F. Goodrich Rubber Company to select Los Angeles County for its $4,000,000 factory.
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Among our Contributors

PROF. HENRY NORRIS RUSSELL

Regularly for twenty-seven years Dr. Russell of Princeton has contributed to our pages a monthly article on astronomy, yet we do not recall that we have ever published his picture. For one thing we could not get him to send us one, and we had to obtain this one from an outside source. In doing this we knew our regular readers were anxious to make Dr. Russell's more intimate acquaintance. Here in the office we always look forward to the arrival of his monthly manuscript, for his articles interest us as much as they do our readers.

HAROLD J. COOK

Harold Cook is the author of "On the Trail of Ancient Man," in this issue. He is an able oil geologist—but his hobby, which he rides hard, is paleontology, the study of evolution by means of fossil evidence. Harold Cook's home ranch in Nebraska is literally "alive" with fossils of Tertiary mammals and it was his boyhood association with them that led him to specialize at the University of Kansas in geology. The discoveries made by and through him may force the revision of some hide bound text-book ideas. Frankly, we hope they will.

Prof. A. V. Hill

If you are interested in athletics Prof. Hill's article on page 124 will hold you. He has been experimenting on the track athlete just as if he were taking indicator diagrams on a locomotive. And after refining his research to a science he finds that the athlete really is a kind of locomotive—so much fuel; so much "steam"; so much speed. It is surprising how exact a science he makes of it.

D. McFarlan Moore

Who first designed golf clubs, anyway, and why did he design them as he did? Is there any compulsion to stick to the present form of club? Suppose a man sat down to redesign the clubs and disregarded tradition entirely, starting anew with only the idea of arriving at the form that was most efficient, what would he work out? That is what Mr. Moore has done in his able article on page 120.

Prof. W. J. Humphreys

Dr. Humphreys' specialty is the weather, but not so much in the ordinary sense of the word as in the sense of the fundamental causes of the weather—the physics of it. He is not the man that makes the weather predictions, but the man that supplies the underlying principles that enable the man that makes these predictions, to make them. Read what he says on page 105, concerning tornadoes.

Dr. F. A. Moss

There are intelligence tests and intelligence tests. At first, when they were new, many people jumped to the conclusion that from them you could deduce a person's capabilities. Now we know better—they only help in a general way. Prof. Moss has found a better way. It recognizes that as a rule people who are good mixers make out best. How to pick these people is told on page 108.

Looking Ahead

with the Editor

ENCEPHALITIS

Epidemic encephalitis is the scientific name of the disease popularly called "sleepy sickness" (some wrongly term it sleeping sickness). How to conquer this dread scourge? Hard work is being put on the problem. Next month Dr. Flexner, head of the famous Rockefeller Institute, will tell us what has been accomplished.

IMITATION

Sir Richard Paget, British physicist and inventor, who has specialized in investigation of the human voice and who has succeeded in producing models which imitate all the sounds of English speech, will tell us how it is done. Oddly enough, you can make an artificial speaking box with your own two hands!

IDEAL

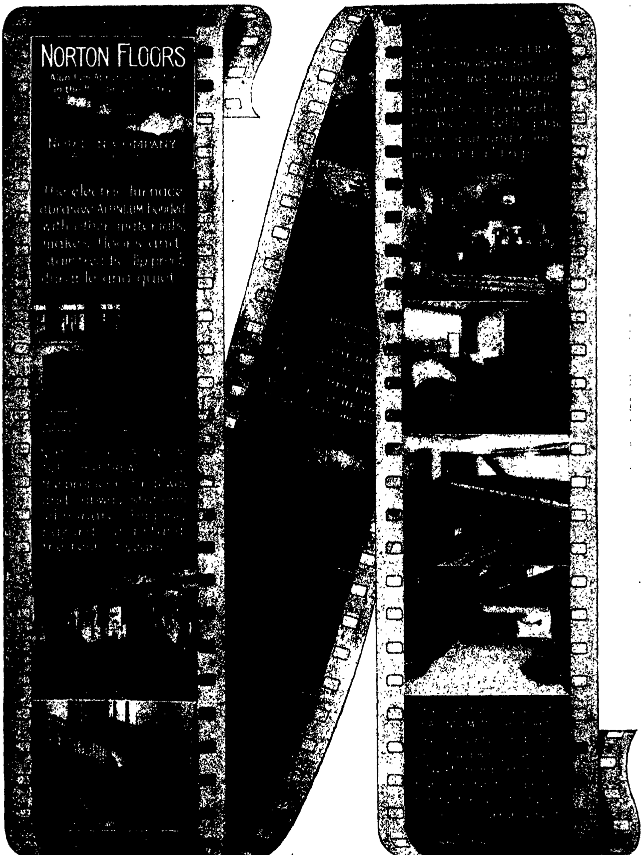
Suppose you could plan a whole city right from the very beginning—no existing features to hamper you. What great fun it would be! That is what Ernest Flagg, the famous architect and innovator in building, has been doing. Next month he will tell you what the ideal city of the future will look like.

TUNNELS

In our next issue, we shall have an article on the opening of the vehicular tunnel between New York and New Jersey. This marks the completion of one of the world's greatest engineering works. Other vehicular tunnels have been built but this great highway beneath the Hudson River, because of its size, capacity and length, stands in a class by itself, and has no competitors.

RACING

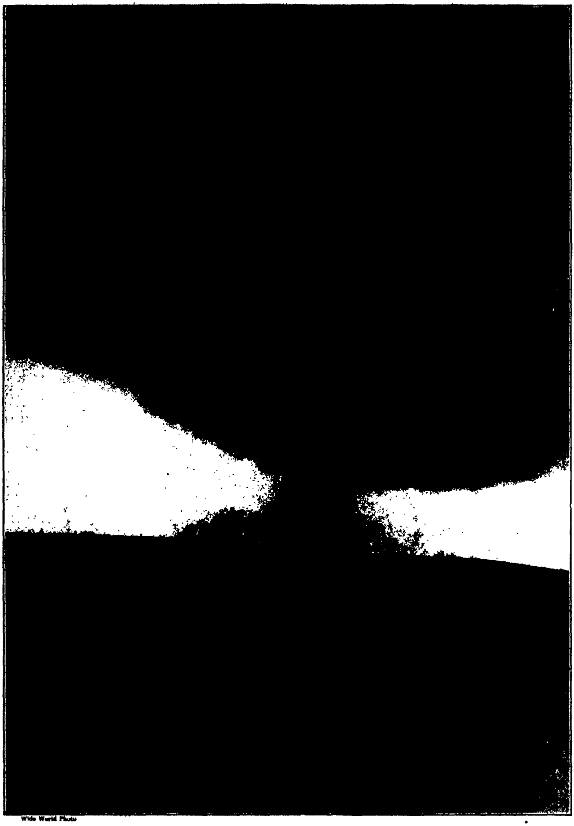
To the mathematician an article to be published next month will reveal some interesting and surprising facts about oarsmen and shell racing, of the general nature of the findings on athletes so brilliantly illuminated by the noted Dr. Hill in the present issue.


NORTON FLOORS

Wide World Photo

COLONEL CHARLES AUGUSTUS LINDBERGH

Called on to write a legend "introducing" Colonel Lindbergh to our readers the editor is rather whimsically reminded of the famous letters of introduction which the modest young aviator thought it advisable to take with him when he flew from New York to Paris, in order to make sure that when he landed he would not have to go about the city of Paris unknown and unrecognized! Nobody in the world now needs to be told whose picture this is and what Colonel Lindbergh did—at least if there is anyone we doubt whether he is a typical reader of the SCIENTIFIC AMERICAN



Two Miles Distant—An Oklahoma "Twister" of Last Spring

There are two motions in a tornado, the whirling motion and the forward progression of the whirlwind as a whole. A tornado becomes visible, according to Dr. Humphreys—author of "The Physics of the Air," a textbook which is noted among scientists, and of the article on the opposite page—because the rapid rotation of the air expands it. When air expands it cools. When it cools its vapor content is precipitated as droplets. These make it visible and outline the tornado.

TORNADO AT LEBANON, KANSAS, 1924

It is only when a tornado happens to cross a populated community that we hear of it. Some of the worst tornadoes pass over open country and do little damage

Our Worst Storm, the Tornado

What Combination of Natural Forces Causes Tornadoes, and Why They Hit the Middle West So Hard

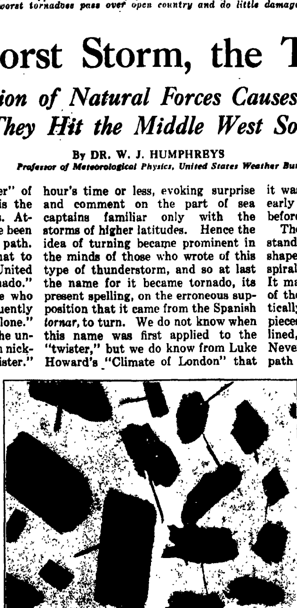
By DR. W. J. HUMPHREYS
Professor of Meteorological Physics, United States Weather Bureau

THE tornado, or "twister" of the American prairies, is the most violent of all storms. Attempts to explain it have been as confused as the wreckage in its path. There even is confusion as to what to call it. The name used by the United States Weather Bureau is "tornado." Many, however, especially those who live in the regions most frequently visited by this storm call it a "cyclone." But the man in the field, with the uncanny accuracy of the freshman in nicknaming professors, calls it a "twister." This is bad enough, but there is more uncertainty still, since the very origin of the technical term "tornado" is in doubt. Furthermore, if its origin is what it seems to be, then the meaning given to it is forced and not inherent.

Most likely this word came, perhaps through bad spelling, from the Spanish word *tronada*, a thunderstorm. For 200 years English sailors used a word like unto this, variously spelled, in their accounts of severe local thunderstorms along the west coast of Africa and on the tropical seas.

These storms often are accompanied by exceedingly variable winds that sometimes box the compass in an hour's time or less, evoking surprise and comment on the part of sea captains familiar only with the storms of higher latitudes. Hence the idea of turning became prominent in the minds of those who wrote of this type of thunderstorm, and so at last the name for it became tornado, its present spelling, on the erroneous supposition that it came from the Spanish *tornar*, to turn. We do not know when this name was first applied to the "twister," but we do know from Luke Howard's "Climate of London" that it was so used in England at least as early as 1809 and in America by or before 1814.

The tornado, as we now understand the term, is a slightly funnel-shaped, circular column of upwardly spiralling winds of great velocity. It may or may not reach the surface of the earth, but where it does, practically everything it touches is torn to pieces. It is not as sharply outlined, of course, as a rotating solid. Nevertheless, the distance from the path of great destruction to the region of little or no injury is so amazingly short that houses on one side of a street may be demolished while those on the opposite side are not injured.



VELOCITY DID THIS

A collection of straws driven end on into the bark and wood of trees, by tornadoes of high velocity

THE width of the tornado track varies from only a few yards to a mile or more, and its length from a few hundred yards to two or three hundred miles. A rough average would be one fifth of a mile across and 20 miles long, or a total area of four square miles. In round numbers there are 100 tornadoes in the United States every year, 250 people killed by them, and 8,000,000 dollars damage done to property. These totals are large, and would be alarming

if we did not recall that they are very small in comparison to the total population and wealth of the nation. If tornadoes were the only cause of death, even we of the United States, where tornadoes are more numerous than in all the rest of the world together, would have a life expectancy 200 times the age of Methuselah. Tornado danger therefore is not relatively great.

Nevertheless, what with the decrease of pressure within the column, roughly 200 pounds to the square foot, and the velocity of the whirling wind, often at least 400 miles per hour, the tornado is dreadful and the things it does are all but incredible.

HOUSES are demolished, their walls blown out and roofs lifted off. Sometimes a house is raised clear of its foundations and smashed to the ground out in the yard or farther away, furniture and even stoves carried high in the air and far away, wagons hurled across the sky, stock blown from one farm to another, generally killed, but occasionally none the worse for their wingless flight; even people borne, as by an Alladin's carpet, but more swiftly and amidst a cloud of wreckage, perhaps half a mile or more, and then dashed to death, or, as sometimes strangely happens, set down gently and left to their own wonderment and thanksgiving. Freight cars have been upset, boards driven a yard deep into the ground, straws stuck end-on through the bark of trees and into the wood, clothing torn from the body, and even fowls somehow stripped of every feather. And so the disasters and the pranks of the tornado, from the terrible to the ridiculous, are of endless variety.

Somewhere in the Mississippi Valley a spring or early summer day has been hot and sultry with a moderate wind from the southwest. Then a towering cumulus gathers in an otherwise clear sky, or more likely in a sky already overcast. Presently, the clouds at a particular place appear to be rushing past or around each other. Then a swaying fog-like column extends down from the place of rotation, and the dreaded roaring tornado is on its course of destruction, with lightning, hail and thunder as mere incidentals.

NEAT TORNADO WORK

Engineers examining a one-inch by five-inch board which was blown through a two-inch by six-inch plank, by the force of an Illinois tornado

But what caused it?

There are only a few ways by which rotation can be produced in a fluid. A vortex can be generated by rotary stirring, but the tornado is not caused in that way. Again, whirling eddies are formed when a stream of fluid passes by an obstacle, as for example when the wind blows past the corner of a house. But this, too, must be ruled out as a possible cause of the tornado. Friction between passing currents generates vortices at their interface, but we know that the tornado is not so produced, because the linear velocity of a particle in such a whirl cannot exceed the velocity of either current with respect to the other, and that no straightaway air current ever passes another with a velocity half as great as the maximum in the vortex of this storm.

There remains but one other possible source of vortex rotation, and it therefore must be the cause that somehow produces the tornado. This is the drawing in, to shorter radii, of portions of the fluid already having some rotation about a center, by virtue of which the linear velocity always tends to increase in the same ratio that the distance from the center decreases. This is the cause of the common vortex in the water of an emptying basin, and of the spin of the familiar dust whirl, which although having some of the characteristics of the tornado is very gentle, originates at the surface of the earth, and spins either clockwise or counterclockwise, whereas the tornado is violent, starts at the cloud level and always rotates in the same sense—counterclockwise in the northern hemisphere.

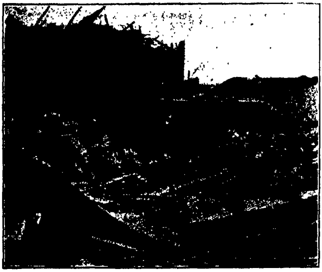
AS already explained, the tornado seldom if ever occurs outside the warm portion of a cyclone, or large area of reduced atmospheric pressure and widespread cloudiness and precipitation. In fact it occurs more or less to the east of the windshift line, a line that in the United States, to be specific, runs from the place of lowest pressure hundreds of miles towards

MORE TORNADO DESTRUCTION

A windmill after a tornado in Kansas. Wind pressure increases very much more rapidly than wind velocity—at 50 miles an hour it is 12 pounds per square foot; at 100 miles an hour, 49 pounds; and so on at a rapid rate of increase

FIFTY WERE KILLED

Griffin, Indiana, after the tornado of March 18, 1925. Out of its population of 350 residents, 55 were killed and 200 were injured by this "twister" which virtually ruined the community for the time. The vehicle shown is a hearse



WHAT AN INDIANA TORNADO DID

A tornado which visited Princeton, Indiana, March 25, 1925, ruined a catsup plant, killed several and did great damage

MORE WRECKAGE AT GRIFFIN, INDIANA

Here is the ruin of someone's home, pieces of broken furniture being visible. Picture your own home reduced to this

the southwest and moves eastward across the country with the travel of the general storm. To the west of this line, the winds are from points north of west. To the east of it, very generally from the southwest. Hence, as this line passes any given place, the relatively warm winds from southerly or southwesterly points are quickly followed by cooler winds from the northwest. This is why it is called the windshift or squall line.

BLACK AND OMINOUS

A tornado at Solomon, Kansas, 1905

The rush of the oncoming colder wind is retarded by friction and turbulence throughout the lower 1500 feet or so. Hence, in this layer the wind commonly grows stronger with increase of height, and therefore in many cases runs forward over the warmer surface air from the southwest, entrapping it and pushing it up to greater heights, just as the warm air in a chimney is pushed up by the cooler and denser air outside. When this warm air is quite humid, as it often is, the moisture in it condenses to cloud as it reaches a moderate height and then, because of the latent heat thus set free, becomes all the more buoyant and swifter of ascent—the higher the worse until the supply of moisture begins to fail.

IN this way many local, turbulent thunderstorms are produced in the general region of the windshift line. Now, these thunderstorms, however turbulent, ordinarily are not accompanied by rapidly rotating winds. Their convection is of lower air all moving in one direction up through another layer where likewise all is moving in a common direction, however different from that at the surface. Neither at the surface, therefore, nor in the overflowing air are the conditions such as to produce rotation, and of course, rotation does not occur. Nevertheless this is the general region in which tornadoes develop.

When the temperature of the southerly air decreases slowly with increase of height, as often happens, and the overflowing air is not very cold, this upper wind sinks through the lower only slightly. If it sank far, it would become warmer, owing to increase of pressure, than the air through which it was falling, and thus become the lighter of the two, a manifestly impossible condition. Hence it merely floats out over the lower wind and the windshift line is in midair, and not, as it usually is, at the surface of the earth.

At this level there is little friction and the northwest wind, having the same velocity through a considerable depth, may have a roughly vertical front of some height against the southwest wind. Furthermore, the northwest wind (as seen from the surface of the earth) and the southwest are both moving eastward at the same rate. Hence in reality they are flowing beside each other in opposite directions, but with the southerly wind, owing to the rotation of the earth, always on the forward or east side.

Convection along the vertical interface between these two winds, one of which, the southern, is very humid, would produce much precipitation, and strong rotation in midair by drawing towards a common center oppositely directed winds on the two sides. This rotation would always be counterclockwise in the northern hemisphere, and when very vigorous would gradually feed down to the surface of the earth and have all the characteristics of the tornado.

THE MIAMI TORNADO

This is the famous storm of 1925

Presumably, therefore, this terrifying storm is caused by convection between walls of northwest and southwest winds flowing past each other along a windshift line in midair—conditions strongly favored by the position of the Gulf of Mexico and the trend of the Rocky Mountains.

Are You Socially Intelligent?

An Analysis of the Scores of 7000 Persons on the George Washington University Social Intelligence Test

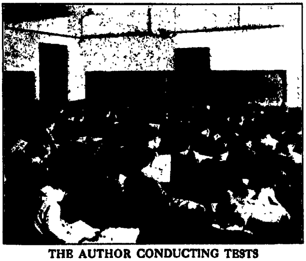
THE Declaration of Independence is wrong! People are neither born equal, live equal, nor die equal. These inequalities among people are just as great in the case of the natural abilities and aptitudes which they inherit from their ancestors as in the amount of money that is left them by these same ancestors. Some are born geniuses; most have only average intelligence; while an unfortunate few have such defective mentality that they must live and die as idiots. Some make friends without effort; the majority have no special ability either for making or for losing friends; while a few have such thorny dispositions that their mere presence is uncomfortable.

One of the most important of the natural abilities in determining success in the world is ability to get along with others. Differences in this trait are now being measured by the Social Intelligence Test, which was devised by members of the Psychology Department of George Washington University. Since its initial publication, two years ago, this test has been used extensively by personnel officers in industry and by 52 different educational institutions. The test has been given to approximately 12,000 persons. About 7000 of these tests were available for analysis. The study has been directed toward discovery of the factors underlying or contributing to this important trait of social intelligence.

IN the analysis, an effort was made to answer five questions: (1) How do the different vocational levels compare in social intelligence? (2) What is the effect of age on social intelligence? (3) How do the sexes compare in social intelligence? (4) Is ability to get along with others inherited? (5) What is the effect of education on social intelligence? Let us now see how these questions are answered from the data.

Is it possible to predict, before he actually tries his hand at it, which person will be able successfully to manage a hundred subordinate employees; which person can negotiate business with members of other business firms; which person can get along with a large number of fellow employees of equal rank; or which individual can successfully deal with numerous clients and consultants? In solving such questions lies the great value of a measure of ability to deal with people. Studies of the Social Intelligence Test being used with the groups discussed in this article indicate the practicability of such predictions.

The accompanying tables show the average ratings or scores on the Social Intelligence Test made by different occupational groups. As we would expect, employees in executive and administrative positions score the highest. These individuals hold positions which demand the ability to get along with others, either with employees under their direction, or with persons of equal ability with whom they must deal in a business way. In this group the chief requirement for success, presupposing, of course, sufficient general ability to manage the details of the job, is superior ability in dealing with people; and it is found in testing them that this is where the superiority actually is. About 90 percent of those who have made good in executive and administrative positions make scores as good or better than the average social intelligence score of employees in positions where no occasion arises for direct dealing with others.



THE AUTHOR CONDUCTING TESTS

The group consists of 200 people. Dr. Moss is measuring the social intelligence of all of them at once

Other occupational groups show gradations in the degree of social intelligence which is required. Those in the teaching profession score high in comparison with occupational groups at large; salesmen for industrial concerns are high; industrial foremen are above average. Those who exhibit least ability on the test of social intelligence are the ones in minor or subordinate industrial positions where there is little need to make adjustments to other people beyond a general obedience to immediate superiors. Their positions practically never require the initiating of social relations, and the demands for skill in carrying on those initiated by others is very slight.

THE scores on the test made by some occupational groups are much more variable than those for other groups. For example, in an average industrial group, half the scores are scattered over a range of 17 points, while in a group of administrative officers the same percentage of scores is limited to a range of 10 points. As a rule, those in positions with high social-intelligence requirements all score high, those in the very lowest types score low, while in intermediate groups a much wider variation is found. This may be partly accounted for by the fact that, within this middle group, seniority has been substituted for ability in the case of some of these; or youth and inexperience have not yet permitted some of superior ability to reach the higher positions.

Within the various occupational groups, the highest scores are, in general, indicative of the greatest success. In one of the higher industrial groups, the highest fourth in ability, as estimated by a superior executive in the concern, all fall in the highest third of the Social Intelligence Test scores. In another group of somewhat lower grade, two thirds of those scoring above average in social intelligence were rated above average in ability to carry on business relationships. Very few cases have been found of individuals with outstandingly high social-intelligence ratings who have been unable to manifest their ability in a practical way; and on the other hand, almost no "shining successes" have been found among those scoring very low on the test.

In school and college groups, ability

to deal with others, both with teachers and fellow students, is an important factor in success. The scores for college students are high, for college graduate students even higher. In the lower school levels, the responsibility of getting along with all concerned rests largely on the teacher; in college, the responsibility is to a large degree transferred to the student; and the graduate student has practically all the responsibility himself. The correlation of school success as measured by school marks with social-intelligence scores is fairly high.

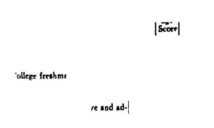
The testing of a large number of individuals in various vocational groups furnishes a basis for arriving at standard scores for each group. These scores, established by testing those already successful in different positions, can be used as standards in admitting new employees or members to the groups. Such a procedure can be followed, since social intelligence is very largely an innate quality or one which is built up in large degree before the vocational stage of life; and not a quality gained by experience in a position requiring it. The point should be emphasized that the "big executive" scores high on the Social Intelligence Test, not because he has gained experience by being a big executive, but because he originally had the ability to become a big executive.

All ages of adult life have their claim as to individuals with high social intelligence. In one business firm in which the Social Intelligence Test was given to the employees, the outstandingly high score on the test was made by one of the youngest members of the organization. In another organization the prize scores were made by older members who had several years ago earned their rank through their ability successfully to carry on business relationships and dealings.

So it is in individual cases in other groups—one school finds that its popular young campus member, who so easily manipulates the school politics or influences his classmates, is rated at the top in social intelligence, while another school finds that some older individuals, who have already made a place for themselves in world affairs but who may be in college to brush up on a few modern theories, come out on top.

An analysis of the scores of a large number of individuals from 18 years of age to average adult age shows that after the age of 18 or 20 has been reached, age has very little to do with their ability to deal with others—or their social intelligence. From early childhood to the age of 18 or 20, one's social intelligence increases somewhat regularly, but after this period there is no appreciable gain. The person of 18 or 20 years of age is just about as likely to make a high rating in these tests as the one of 35 years.

Scores for Various Occupational Groups



The average social-intelligence scores of several hundred upper-class college students of different ages vary within only a few points out of 160. College freshmen show slightly more variation but no definite age tendency. Industrial groups composed of individuals of about equal industrial rank similarly, show closely corresponding scores for different ages, the slight advantage being in favor of the younger worker. The slightly higher standing of the younger worker can be accounted for partly by the fact that those who would have made the highest scores in the older age groups have moved on to a higher industrial group, largely because of their innate higher ability, of which social intelligence is a factor. This would seem to indicate that, although the young men may be denied the better jobs because they are too young, the justice of this procedure cannot be based on undeveloped powers in this innate ability which is one contributor to success.

Average Scores According to Age.

An analysis of the separate factors in social intelligence in relation to age gives a few interesting findings. There are certain separate factors which have a tendency to vary with age. The older individual is usually found to have greater breadth and variety of interests, and, since being interested in what others are interested in bears directly on ability to get along with them, such a difference may be significant. This difference is borne out in the Social Intelligence Test by the higher scores on a test of social information made by the older individuals. From high school groups to college groups in which age is one important difference, although it must be remembered that there are many other differences to be considered, the average score in social information is increased about 50 percent; while in the abilities of memory for names and faces, and interpretation of emotions from either facial expression or spoken words, the increase is usually less than 15 percent. Within the college group itself, and within business groups, the social information score is found to increase with age, but less markedly.

In judgment in situations involving relationships with others, the experience accompanying age adds some to the accuracy or correctness of judgment; but with increased experience and resources in the form of a greater number of criteria against which to evaluate solutions of social problems, the individual seems to lose in speed of making his judgment. The younger individual has a tendency to make his judgments in dealing with others a little more quickly but he is a little less likely to reach the best solution. Other factors show only slight variations attributable to age, beyond the change in ability which one would find on any written test in advancing from the child to the adult person. Age with its accompanying experiences may be expected to increase one's fund of social information and his criteria of social judgment, but the slight gains that he makes in these respects seem to be offset in other respects.

In general, we must conclude that what the individual does not possess in ability to deal with others at 16, he is not likely to possess in high degree as he reaches middle life or old age. The individual who, in youth, cannot make social adjustments with his classmates, who cannot deal successfully and amicably with problems involving his classmates, who rubs people the wrong way or forgets the courtesies due them, will do likewise in later relationships where his classmates have changed to business associates or his school problems to business deals.

Is one sex naturally more socially intelligent than the other? A canvass of popular and scientific opinion shows a vote in favor of the women. Popular opinion takes its stand on the supposedly greater need of women to get along with people, greater interest in social affairs, and a tendency toward agreement or acquiescence in circumstances where the man would argue or fight. Scientific opinion cites the psychological studies attributing to women greater interest in people as compared with man's greater interest in things. Analysis of over 1000 scores on the Social Intelligence Test for college men and women does show the women to be slightly superior

Wherein does the superiority of the women lie? An examination of the separate factors of social intelligence may help to answer this. First, it is found that the difference does not lie in ability to remember names and faces —for here no appreciable difference between the sexes exists. The average scores on a test of memory for names and faces are practically the same. The only tendency found, although this is not significant, is for the women to remember faces better and the men names better. The chances are just about equal that Mr. Jones or his wife will remember you after you have been introduced to them once.

Nor is the superiority of women due to better ability to interpret human emotions. In seeing the mental state behind either the facial expression or the spoken word, equality of the sexes is the rule. One sex may be more emotional or more inclined to express emotions, but this does not carry over to a difference in ability to interpret emotions when they are expressed in others.

IN range of interest or social information, the men even surpass the women. As measured by a test of 50 questions on social information, the men usually score from 15 to 20 percent better than the women. Whether men have an innate superiority along this line or whether they have had wider contacts and opportunities to develop interests and acquire information is not certain, but however the case may be, in this respect they possess a present advantage.

The two factors which analysis has revealed as accounting for the higher social sense or intuitiveness of women are the ability to make judgments in social situations requiring tact for their solution, and observation of human activities which serves as a basis for the predicting of behavior in others. Women score from 15 to 25 percent better in these abilities than men usually do.

Differences may be indicated by a few concrete examples from the test. Women are successful in recognizing the falsity of these statements about twice as often as are men:

> "The more uncivilized and superstitious a nation is, the higher is the rate of suicide."
>
> "By original nature we find it satisfying to be alone in our beliefs and opinions."

Men fail to recognize the truth of these generalizations over twice as often as do women:

> "We are more shocked by our errors in etiquette than by those in logic."
>
> "Few people hesitate to lie to escape an unpleasant engagement."

Differences in the use of tact in meeting social problems can be specifically illustrated by two of the problems presented in the Social Intelligence Test. First, to take an example of friendly social relations; in deciding on a book suitable for a gift to a friend, the alternatives are to find out from the friend what kind of books he likes, to ask advice of a book dealer, to give a book you have enjoyed, or to give a "best seller." Eighty-eight percent of the women chose the first alternative, which is obviously the best thing to do. Only 68 percent of the men would do this.

To take a situation involving business relationships, the problem is presented of dealing with a business associate who has no authority over you but who dictatorily tells you to do a thing quite differently from the way you had intended. All except about one fourth of the women would ignore him, which is the best way to meet the situation. A much larger percentage of men would attempt to meet the problem in a different way, a considerable number choosing to take the aggressive attitude of telling the associate it is "none of his business," or telling him to do the job himself.

What may these differences mean in a concrete way, if anything? It may mean that, other things being equal, man has a little better chance of holding the prospective business client or benefactor by appearing intelligently interested in his hobby or by being able to discuss the topics of conversation in which the latter is interested; but that woman has a little better chance of selecting the right tactics to use in bringing the client or benefactor to the desired point of view, or of predicting his reactions under a given set of circumstances. It would seem that man is to be given the preference in initiating social relations, woman in safely completing them.

IF an individual can get along successfully with his associates, the chances are much in favor of his brother possessing a like ability. The Social Intelligence Test scores of 38 pairs of siblings were studied. While this number of cases is admittedly too small to permit any sweeping conclusions, it is enough to indicate certain tendencies.

In all cases where the resemblance between children of the same parents have been investigated, there has been found to be a positive correlation. Brothers and sisters tend to do work of similar grade in school, they show considerable resemblance in abstract intelligence, and the correlation between brothers in physical traits is as high as .50 or .60. The correlation between the Social Intelligence Test scores of brothers and sisters is not so high, being about .44; but it is high enough to indicate that inheritance plays a very important part in determining ability to deal with others.

The inheritance of social intelligence is evidenced in families of statesmen, politicians, and courtiers. History is so full of instances where several members of the same family have made shining successes in the fine art of human engineering, that no one can doubt that our amount of social intelligence is just as much a part of our inheritance as is our stature.

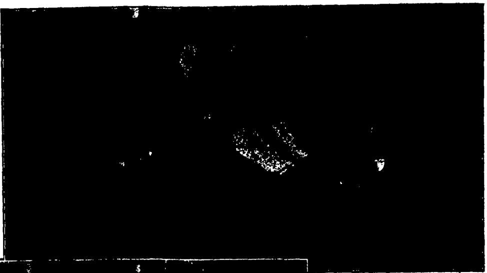
And so it is seen, that one's success in the fields of the various vocations or the preparation for the various vocations is determined in no small part by the amount of social intelligence with which he is born.

MENTAL STATES INDICATED BY FACIAL EXPRESSIONS

Business executives surpass all others in tests for the perception of such indications

ELECTRIC "SCOOTER"

The miniature electric roadster illustrated at the right is so designed that on one charging of its two six-volt batteries, it will travel at [illegible] for 20 to 30 [illegible] the road [illegible] t is only [illegible]sary to pres[illegible] a small [illegible] pedal. This actuates a two-step resistance, thereby making the vehicle start smoothly and pr[illegible] the placing of a su[illegible]n load on the battery. T[illegible] brakes are provided, one operated by hand and the other by foot. When either brake is actuated, the circuit is broken



Underwood and Underwood

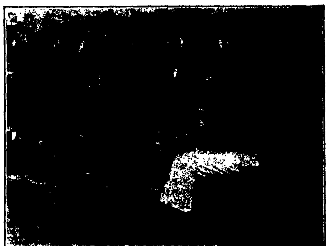
PORTABLE AUTOMOBILE

The tiny single-cylinder gasoline engine in the small automobile illustrated at the left is capable of driving the car at a speed of 12 miles per hour, with remarkable economy. Because of the extremely small size of the vehicle, it can "wriggle" its way through heavy traffic with ease, and can be parked in a very small space. In fact, it can be parked by the simple expedient of picking it up, one end at a time, and carrying it into the parking space. The machine is equipped with standard bicycle wheels and tires. The chassis is of the buck-board type

P and A

A MOTORCYCLE DE LUXE

The side-car of this outfit is fully equipped with every convenience and safety device, and is said to have cost 2000 dollars. It has 12 electric lights installed in it



Wide World

MOTOR-WHEEL "SCOOTERS"

These little motor vehicles, using motor wheels, were designed and built by two seniors at Massachusetts Institute of Technology. They can travel at a rate of 25 miles per hour

Novelties in Automotive Transportation

Every once in a while we see some type of freak motor vehicle on the streets. In the above photographs, we present four representative types. Probably the most interesting of them, at least from a financial viewpoint, is the motorcycle outfit illustrated in the lower left-hand photograph. The motorcycle itself has three warning signals—an electric horn, a hand horn, and a whistle. The side-car is fitted with 12 separate electric lights, and the seat can be so adjusted as to form a comfortable bed. The side-car cover is completely waterproof, and is equipped with sliding windows on both sides. Specially designed springs make the vehicle exceptionally easy riding.

OUR POINT OF VIEW

THE MOTOR AND THE MAN

IN speaking of transatlantic flights, it is no disparagement of the man to place a reliable motor in the first position as the absolutely indispensable element for a continuous non-stop flight across the northern Atlantic. Three times this supremely hazardous feat has been accomplished—first by Alcock and Brown in 1919 in a twin-engined, military bombing machine and eight years later by Lindbergh and Chamberlin in monoplanes, each driven by the wonderful Wright Whirlwind engine—these last two flights of 1927 being made with a brief interval of only two weeks between them. In each case the engine represented the highest development of the gasoline engine of its day—the Alcock plane being driven by water-cooled Rolls-Royce engines—the Lindbergh and Chamberlin monoplanes carrying what is universally admitted today to be the most reliable air-cooled airplane motor ever produced. It has to its credit the long-distance record of over 51 hours in the air made by Chamberlin in his Bellanca plane, some few weeks before he made his flight from New York to Germany.

Until recent years, the plane itself has been well in advance of its motor in respect of reliability. Smith in his flight of 14,000 miles to Australia over an unchartered course, Cobham in his flight of 12,000 miles from London to Cape Town and back, and shortly thereafter in his flight of 24,000 miles from London to Australia and back, the flight of our army fliers around the world and the flight of Byrd from Spitsbergen to the North Pole and back in his great Fokker tri-motor monoplane—all these and many others have shown that the plane itself has reached a point of absolute reliability.

And now the marvelous flights of Lindbergh and Chamberlin have proved beyond question that the motor has been brought up to the same high pitch of reliability as the plane.

As regards the man, in such daring flights as that across the northern Atlantic, we must remember that in the three instances where this has been accomplished, the aviator has been a man of long experience, possessed of an unusual air-sense, and thoroughly familiar with the atmosphere's troublesome vagaries. Alcock was a veteran war pilot and both Lindbergh and Chamberlin have been brought up in that wonderful school of experience, the Air-Mail Service. Do not for a moment imagine that just any pilot, even though he were provided with the same excellent planes and motors, could have gone out and done what these young men so brilliantly accomplished. All three of them ran into difficult air conditions; Alcock and Brown flew almost continuously in fog and thick weather, so much so that Navigator Brown had to wait many hours in the air before a rift in the clouds allowed him to take an observation. Both Lindbergh and Chamberlin had to contend for many hours with the peril of ice and sleet.

The reason why young Lindbergh's feat has so captured the imagination and enthusiastic applause of the world is to be found in the quiet courage with which he flew across America and then, at the first intimation from the Weather Bureau of favorable conditions on the Atlantic, climbed into his machine and swept out to the great adventure, utterly alone, and made his objective, •3600 miles distant, with unerring accuracy. Couple with this the native modesty with which he has taken the amazing honors which have been showered upon him, and his absolute refusal to commercialize his exploit in a world which is saturated with commercialism, and you have an explanation of the warmth with which a war-wearied and money-satiated world has taken this fine young American lad to its heart.

> **Ex-Secretary Hughes says:**
>
> "... men and ... this exhibition in this flight of our young friend. Our boys and girls have before them a stirring, inspiring vision of real manhood. What a wonderful thing it is to live in a time when science and character join hands to lift up humanity with a vision of its own dignity. There are again revealed to us with a startling suddenness, the inexhaustible resources of our national wealth. From an unspoiled home with its traditions of industry, of frugality and honor, steps swiftly into our gaze this young man, showing us the unmeasured treasures of American character. America is fortunate in her heroes; her soul feeds upon their deeds; her imagination revels in their achievements. There are those who would rob them of something of their luster; but no one can debunk Lindbergh, for there is no bunk about him. He represents to us, fellow Americans, all that we wish—a young American at his best."

SHALL WE FLY THE ATLANTIC?

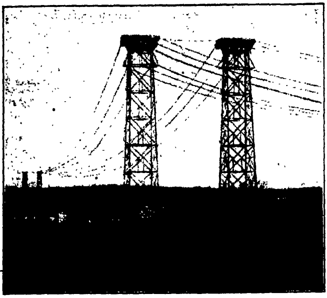
SHALL we—the general public—ever fly the Atlantic? Some of us will, undoubtedly, but how many and when, who can tell? Lindbergh, the beloved, says we shall, some day; so do Byrd, Chamberlin, and all of the men whose flying experience is such as to give great weight to their predictions.

Let it be noted carefully however, that when these men predict a coming transatlantic passenger service, they are careful to preface their forecast with many an "if" and "when."

An outstanding condition, which must be met if transatlantic passenger service is to be established, is a well-equipped, Atlantic, meteorlogical service. We say this without any disparagement of the excellent work of the Hydrographic Office of the Navy which, many years ago, arranged with the various steamship companies, and of course with its o... ships, to supply the home office v... data as to the direction and strength of the winds and the general atmospheric conditions; these data being published on the famous hydrographic charts of the office. The United States Weather Bureau also, although its duties are concerned mainly with weather conditions within or affecting the United States, has furnished the recent transatlantic fliers on request, with up-to-date information as to existing and probable future weather conditions on the Atlantic.

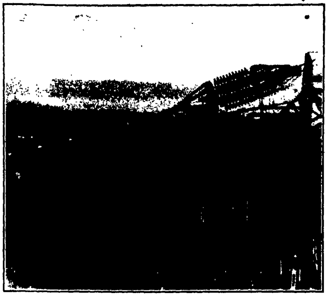
But before the traveling public is permitted to commit itself to a transatlantic airplane service, it will be necessary greatly to enlarge the present facilities for weather forecasting and render the forecasts so complete that, when a pilot launches his multi-motored plane and its precious freight out upon the vast reaches of the Atlantic, he will know with great certainty what kind of weather to expect and what detours he must make to avoid fog, snow, and sleet, or opposing winds that would use up his fuel supply before he reached American or European shores or some established landing between. Of such vital importance is this that we think the government would be justified in establishing, whenever the time is ripe for it, a special Atlantic meteorlogical office.

We are inclined to agree with Mr. Bellanca that a three-stage journey would be advisable, with stopping points at Newfoundland and the Azores. The planes would have to be large and of metal construction. Moreover, they will probably be monoplanes, developed along the line of the machine with which Commander Byrd flew to the pole and back. They will be driven by aircooled motors, varying in number according to the size of the plane.



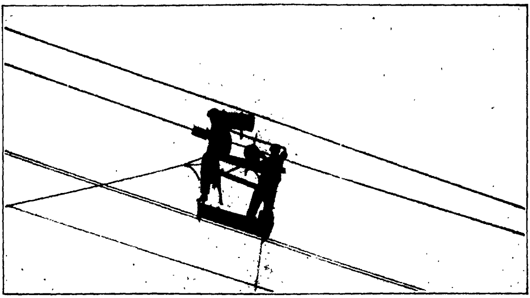
THE MILE-LONG SPAN

The seemingly impossible task of painting these slender steel cables was accomplished by the simple method described in the text and illustrated directly below



STARTING THE JOB

The sheaves supporting the car have been placed on one of the power cables and the task of applying the paint has been started. Note the insulators on the cables



CLIMBING AN UP GRADE

When approaching the end of a cable, the car is moved up the grade by means of a hand crank geared to a rubber-faced sheave, which bears on the cable, thus providing the necessary traction

Painting Mile-Long Cable Made Easy

Across the Narrows, a part of Puget Sound near Tacoma, Washington, stretch several strands of slender steel cable. These cables carry current which is destined to be used for light and power at distant points, and to keep them in good condition, it was recently found necessary to paint them. At first glance, such a proposition might seem impossible, but, after careful planning of every step, the paint was applied to the cables with little trouble and the job was completed without a mishap. The device which helped the painters immeasurably was a small car with special equipment, which was designed to be suspended from one of the cables and moved along it by hand power. The car was hung from two sheaves, one placed over each end of the framework of the car. A third sheave, with a rubber face, was placed in firm contact with the cable. This latter part was equipped with a brake and was geared to a hand crank. When traveling on a down grade, the brake was used to control the speed, and when on an up grade, the hand crank was used to provide the motive power. The method of applying the paint to the steel cables was a novel one. Instead of being brushed on by hand, it was automatically fed through special brushes. These consisted of two semi-cylindrical blocks of wood, each provided with bristles. These two half-cylinders were arranged to be clamped around the cable under treatment, and the paint was fed to them from the 15-gallon can placed over the framework of the car as shown in the above illustrations. As the car moved slowly along the cable, the paint was applied evenly to the metal surface. The car was raised to the top of the end tower on the anchor cables, from which point it was transferred to one of the power cables.

SCIENTISTS IN THEIR WORKING CLOTHES AT THE NEBRASKA SITE

Left to right: *Glenn Jepson, paleontologist, Princeton University; Prof. Wm. K. Gregory, comparative anatomist, Columbia University; Prof. W. J. Sinclair, geologist and paleontologist, Princeton University; Albert Thomson, Chief Field Man, the American Museum of Natural History, leader of the expedition and discoverer of the oldest implements believed to have been made by ancient man; a student*

New Trails of Ancient Man

Remarkable Finds of Ancestral Man Have Recently Been Made In Nebraska and Oklahoma

d History, Denver

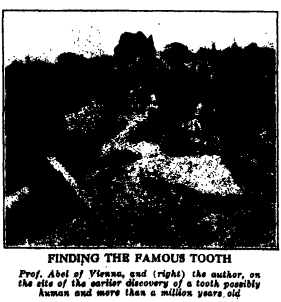
IT has frequently been noted that great discoveries come in waves. Periods of quiescence are followed by periods of activity and advancement. We are now in an active stage of the recovery of the history of extremely ancient man in America.

Technically called paleoanthropology, the subject of early man is now attracting far wider interest than at any previous time; and the most important and striking of the evidences yet found, and some of the earliest known traces of the human race, have but recently been discovered in this country.

AS no such evidence of early man in America had been found which was not subject to question regarding its degree of antiquity, a school of skepticism has developed, which holds that really ancient man did not exist on this continent, and that man came to it only a few thousand years ago. Individuals have shown a tendency to become extremely dogmatic in their pronouncements in this direction, as if all the evidence were now in and the final decision rendered.

Fortunately, however, true science is not dogmatic nor is it typified by pronouncements of what "cannot be." Instead, it seeks through every possible avenue of information to assemble and coordinate all available facts, and to evaluate and interpret them without bias; and it fully realizes that opinions can neither alter nor replace facts, regardless of how unexpected they may be.

With this point of view let us consider the evidence offered by some very recent discoveries.



FINDING THE FAMOUS TOOTH

Prof. Abel of Vienna, and (right) the author, on the site of the earlier discovery of a tooth possibly human and more than a million years old

In 1908, Dr. W. D. Matthew of the American Museum of Natural History, New York City, and the writer discovered a series of ancient stream channel beds that now form gravel and sand ridges on the top of the watershed of a high divide between the North Platte and Niobrara Rivers in northwestern Nebraska, near the famous Agate Spring Fossil Quarries. These channel beds contain the fossil remains of an exceedingly rich and varied sub-tropical fauna, comparable in its numbers and variety to the great modern big game regions of Africa.

Expeditions have explored and dug in these beds each year since their discovery. Every year new evidence has been revealed, and some of it is of extraordinary interest. The former existence of a wide range of prehistoric life has been demonstrated, with many elements of far-reaching interest. A great variety of mammals, birds, reptiles, amphibians, fish and plant life is represented by the fossils, most of the animals being entirely new to science. New light has been thrown on climatic conditions in former geologic times, on intercontinental migrations of animal life, and on other matters of prehistoric interest.

WE find in those beds the first fossil evidence of true anthropoid primates ever found on the American Continent!

Of flesh eaters there is a most astonishing variety. Cat and dog relatives, from tiny to enormously large; and the relatives of modern mustelines such as mink, weasels, wolverine and their kind, were plentiful and of many kinds. Fossil horses in the three-toed

SOME OF THE FINDS

About a hundred objects such as those shown below, just as they were dug up and thrown out on the bank. In the background, the scientists' camp

stage are abundant. Several kinds of elephants (using the term broadly) are present, and all of them are types that lived before the mammoth. Numerous antelope and deer-like forms, some large and some tiny, are found. The first true bovids known to have reached America were discovered here.

Some of the families just mentioned show distinct relationships to Asiatic forms, and bear evidence of having migrated from that continent, over the land-bridge known to have existed at their time, connecting Asia with North America. Camels, great and small, were plentiful and of several kinds. Peccaries of various species, related to the little "musk-hogs" now living abundantly in places in northern Mexico, were there in numbers; also there have been found the very earliest known migrants from South America, small edentates—toothless mammals, like armadillos and ant-eaters—showing that a land connection had also been established with South America by this time, as mountains rose out of the ocean floor, forming the region along Central America.

Alligators big and little, and giant lizards several feet long, lived in Nebraska! Some of the birds show relationship to tropical species, further demonstrating the warm climate. A great variety of fossil wood, of many tree families, is preserved; and also fossil seeds and plant impressions. All of these things, both wood and bone, are completely turned into stone (silicified). The things mentioned constitute only a partial list of the great variety of life represented in these fossils.

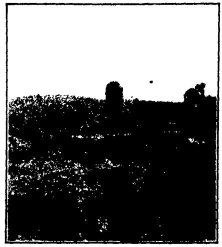
DURING the warm Pliocene period which preceded the glacial stages of Pleistocene time, this abundant fauna flourished; and with it has recently been found startling evidence of the presence of beings who must be closely akin to ancestral man!

While searching in the Snake Creek Beds (as we had named these channel beds for convenience), the writer found a single upper molar tooth, black and perfectly petrified, which appeared to be a fossil human molar! But, as these beds were admittedly hundreds of thousands of years older than the oldest known traces of humanity, we naturally felt very skeptical and incredulous, and felt that it must belong to some other unknown type of mammal, whose molar teeth simulated human teeth. However, repeated studies always brought us back to one point, that is, that the original possessor of the tooth *must* be related to ancestral anthropoid-humanoid stocks!

After keeping this tooth nearly five years in our private museum at Agate, Nebraska, hoping meanwhile that additional evidence might be secured, the writer decided to submit the specimen to Professor Henry Fairfield Osborn, President of the American Museum of Natural History, New York, as the man of all Americans best equipped to make certain and accurate comparisons and determine its real relationships. This was done; and Professor Osborn verified this determination and announced the discovery, recording it as the first occurrence of anthropoid - humanoid stocks to reach America.

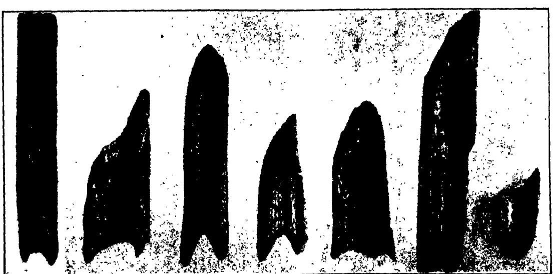
Following this, further expeditions were sent out by the American Museum, and many interesting and important discoveries were made. Unfortunately, the spot where the original find was made was on the land of a ranchman who took no interest and showed no intelligent understanding of the importance of such discoveries; and he arbitrarily ordered all work stopped on his premises!

This misfortune proved to be a blessing in disguise. Mr. Albert



POWER WAS EMPLOYED

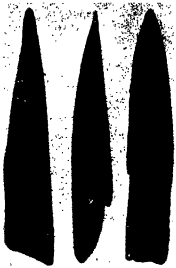
A gasoline-driven air compressor furnished the means of blowing the earth away from the discovered objects without the usual danger of injuring them



Courtesy of the American Museum of Natural History

TYPICAL SAMPLES OF THE OBJECTS FOUND IN WESTERN NEBRASKA

..., ...lar objects, literally fossilized and ring like ston



A COMPARISON

The bone implement in the center is from an Aztec collection. The others are from the Nebraska site

Thompson, Chief Field Man and Preparator of the American Museum, finding himself barred from this "Land of Promise," moved across the fence to an adjoining ranch, whose owners took great interest in the work. Here, in a most unpromising location, his keen eye located evidence that, of its kind, is one of the great discoveries having to do with early man. In undisturbed, original deposits, associated with the wonderful array of Pliocene fossil animal life described above, he found evidence of the first culture known to have been developed by the human race, and the oldest trace of humanity, by hundreds of thousands of years!

THE evidence seems to indicate that these beings made artifacts (implements) of the green bone of the contemporaneous animals. Some of the bones are drilled; many are shaped and sharpened in various forms; while others must have been used for pounding. Many show evidence of artificial abrasion of different types.

Critical preliminary studies of these first human implements or tools has been made by Prof. Osborn and Mr. Thompson. This discovery is opening a whole new chapter in the history of the human race, and carrying the age of Man, capable of tool-making, vastly farther back than most students of the subject have anticipated. Especially was it unexpected to find such evidence in America!

Let us now turn to another piece of evidence that ancient man existed in America—one from a locality hundreds of miles south of the one just described. In the November, 1926, issue of the SCIENTIFIC AMERICAN the writer published an article on primitive man in America. In December following the publication of this article, the editor of the SCIENTIFIC AMERICAN received a letter from Dr. F. G. Priestley of Frederick, Oklahoma, stating that he had read the article, and that in his opinion interesting scientific evidence existed near his community. His letter indicated the probability that an important discovery might be made; and Mr. Albert G. Ingalls, Associate Editor of the SCIENTIFIC AMERICAN, forwarded the letter to the writer, suggesting that we might be interested in looking into the possibilities.

Early in January, the writer went to Denver, Colorado, and called these letters to the attention of Director J. D. Figgins of the Colorado Museum of Natural History. Arrangements to investigate the evidence were immediately completed. Late in January, the writer drove Mr. Figgins from Denver, through New Mexico and Texas, to Frederick, Oklahoma, and found there some of the most important and ancient evidence of early man known in America.

A MILE north of Frederick lies the highest hill in the region. This hill is really the end of a long rambling ridge, running north, away toward the Wichita Mountains some thirty miles distant. This hill or ridge is composed of coarse sand and gravels which lie directly on an old worn and eroded face of Permian Period Red Beds. About a mile north of town, Mr. A. H. Holloman owns and operates a commercial sand and gravel pit; and it was during the work of excavating this large pit that the evidence in question came to light.

The geological evidence shows that the sand and gravel had once been carried in and bedded in its present position in rapidly moving water; and that the top of this, the highest hill in the region, was actually once the bed of a large prehistoric river! Considering the fact that the top of the hill is now over one hundred feet above the surrounding valleys immediately joining, and some two hundred and eighty feet higher than the present Red River which now drains the region a few miles away, it becomes obvious at once that this is by no possibility a recent river bed!

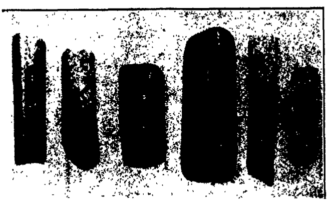
Evidently, then, a large river valley has become essentially inverted through erosion, so that the part that was the lowest has become the highest. This inversion was brought about by the hard granitic sands and gravels which flood waters had swept into the channel. These had become firmly bedded and "set," so that they were far more resistant to erosion than the surrounding Red Beds in which the old valley had first been cut out. Endlessly repeated rains and winds, freezing and thawing, and melting snows, in their ceaseless progressive destructive action, wore away the softer Red Beds, while the gravels held their own, resisting removal. Gradually the whole surface of the surrounding region wore down until banks no longer existed high enough to hold the stream to its bed.

IN OKLAHOMA

The Holloman gravel pit at Frederick, where other new evidence of ancient man in America was unearthed

At this point, a transition stage set in, during which the old valley no longer carried the main river, but its old bed was still subject to periodic flood-plain overflow. Finally this ceased, as the surrounding region eroded more deeply, and the stream migrated away as lower channels were formed in the softer flanking beds.

A third stage now set in. Winds in dry periods lodged dust on top of the old flood-plain sediments, leaving a thin, typical aeolian or wind-deposited bed. The face of the Holloman gravel pits bears evidence of just this



MORE OF THE NEBRASKA DISCOVERIES

Fossilized bone objects which bear close resemblance to beads made comparatively recently by American Indians

sequence of deposits, as shown below.

On the irregular Red Bed floor, there lies about seven to fifteen feet of cross-bedded, river channel bed gravels and sands, coarsest at the bottom, and in part cemented into hard, dense rock. Overlying this are some five to seven feet of flood plain wash, coarse and fine. On this lie about three to five feet of aeolian silt and prairie soil. For convenience, we may call these beds A, B, and C, in the sequence cited above in the order of their deposition. (See drawing.)

THE old river bed that forms the cap of the hill is roughly half a mile wide, and many miles long. Buried in undisturbed deposits of this old stream bed, down in the lower "Bed A," and associated with the bones of many extinct and typical Pleistocene (ice age) animals, were found stone implements made by man!

Strangely enough, these implements show a degree of culture closely comparable with that of the modern nomadic plains Indians. This partly confirms and makes more probable the suggestion made by the writer in the November, 1926, issue of the SCIENTIFIC AMERICAN, namely, that possibly such Indians had changed but little in a long period of time in America. Failure to recognize such a possibility has probably been the chief cause of the failure of able authorities to realize the antiquity of man in America.

It now appears to me quite probable that these very early people *were* closely comparable in most ways to our modern Indian, structurally as well as in culture; and if so, this would account for the errors in interpretation as to man's antiquity in America, fallen into by some talented scholars.

The animals found and identified in Bed A with the artifacts are undoubtedly but a small fraction of the fauna of the time. Three types of elephant occur, two of which are of the type popularly known as mammoths. The other is a more primitive mastodon-like form (to stick to common names). The elephants of America were all originally migrants from Asia, although they had been well established a long time in America before Pleistocene times, having first come to America about Middle Miocene time. Three genera of edentates occur, all originally migrants from South America. Two are the large ground sloths, Mylodon and Megalonyx, distant relatives of the little tree-dwellers of South America of today. The third, Glyptodon, is a peculiar fellow with a back armor or carapace that strongly reminds one of a turtle shell, but of very large size. Two species of camel, and at least three species of fossil horse occur. All of the latter are of our

DR. F. G. PRIESTLEY

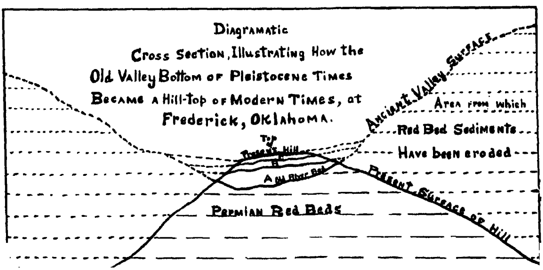
Last December Dr. Priestley found evidence of very ancient man, near his home at Frederick, Oklahoma. He at once reported it to the SCIENTIFIC AMERICAN which turned it over to Mr. Cook, the author, for investigation

modern genus *Equus*, but of species that were abundant in Pleistocene times.

Regarding the time required to accomplish the surface erosion obviously brought about since those animals and men lived in Oklahoma, we may get a general idea from the following facts. They are taken from careful records kept at the mouth of the Mississippi River, on the solid or mud content of its waters. Careful computations based on these studies indicate that about one inch in 750 years is being removed from the whole face of the country drained by the Mississippi river system from the Alleghenies to the Rocky mountains. That amount is being removed under the present average precipitation, climatic conditions and altitude factors. We know, however, that these conditions are variable, and that they have differed widely from time to time in the past. Nevertheless, this information provides a rough basis for calculation. At this rate, it takes 9,000 years to remove one foot from the surface of the region. To cut the surface the depth of the local valleys would therefore take about 900,000 years; and to develop the drainage down to the present Red River level, 280 feet below, would require the appalling time of 2,520,000 years.

THIS is undoubtedly excessive. We know that during part of Pleistocene time erosion was much more rapid than now, and we are possibly justified in cutting that estimate in half on that basis. Then, to allow for other possible errors and to be conservative, if we cut that figure in two twice more, we will still have indicated an astonishing lapse of time *since* that stream ran where the hill-top now is!

Geologically speaking, the 365,000 years indicated by these figures is not long. The geology, the stratigraphy, and the animal remains found, all confirm the age of these beds. While not as old as the Pliocene culture from Nebraska, described above, I believe this Frederick, Oklahoma, discovery furnishes the most conclusive evidence of Glacial Age man yet found in America.



HOW A FORMER STREAM BED CAME LATER TO FIND ITSELF THE CREST OF A HILL

This is described in detail in the text. Such a peculiar sequence of events is familiar to geologists

Cipher Messages of the Stars

How the Modern Spectroscope Reveals Secrets to the Astrophysicist

By HENRY NORRIS RUSSELL, Ph.D.
Chairman of the Department of Astronomy and Director of the Observatory, Princeton University
Research Associate, Mt. Wilson Observatory of the Carnegie Institution

A YEAR or so ago we had occasion to speak of some of the dreams of astronomers, and how they have come—or may come—true; but they were not all told. The student of the spectrum has dreams of his own. He realizes, as his forebears have for nearly two generations, that the spectrum which we obtain by sending the light of a star through a prism is not the meaningless number of lines that it appears to the uninitiated glance; it is a series of cipher messages from the star.

Like some human messages in cipher, the message of the spectrum is effectively concealed from the casual glance. Just as some messages written in "invisible ink" can be recognized only when the sheet on which they are penned is examined in light of the right color, so the very existence of the message of the spectrum is revealed only when the star's light is spread out by a suitable instrument which separates the innumerable varieties of light of which it is composed, and enables us to perceive that some are faint or absent.

The photographic plate, behind the slit, lenses and prism of the spectroscope, enables the astronomer, then, to do what the military intelligence officer does by his zealously guarded devices—to detect and copy the concealed message. But when the message is in our hands, it must be decoded and interpreted, and this takes still greater skill.

THE main outlines of the spectroscopic code have been known for sixty years. Each chemical element—or for that matter, each separate chemical compound, if it can exist without decomposition on the star—gives us its own characteristic pattern of lines, which reveal its presence. A qualitative analysis, as the chemist would call it, of the sun and the stars has therefore been practical for many years, and we have been able say, too, in a rough way, that the elements that give strong lines in the sun must be abundant there, and that those which give only faint lines are probably present in relatively small quantities.

But the chemist is not satisfied with a qualitative analysis; he makes it quantitative, and finds what percentages of the various elements are present in his samples. Can we do the same for the stars? And can we get any information from the spectrum concerning the pressure and the temperature in the atmosphere of a star, when the spectral lines are formed? The work of a host of workers, theoretical and practical, in the last ten years has shown us that there is far more to be read from our stellar spectra than we once supposed. Keeping up our analogy, we may say that the older methods told us what letters corresponded to the symbols of our cipher, and enabled us to read the message in pronounceable words, to tell in what language it was, and get its superficial significance. Now we can go behind this and find out a great deal about the circumstances under which the message was written, and the fuller meaning of its phraseology.

THE LABORATORY IN PASADENA

In addition to the great group of astronomical instruments on Mt. Wilson, near Pasadena, a splendidly equipped laboratory and office is maintained in the city itself. Here some invaluable collateral research in astrophysics has been performed by the Mt. Wilson Observatory Staff

We know quite well what changes happen inside the atoms when the light of some particular spectral line is absorbed; and, if we know what the atoms of half a dozen kinds are doing in a star's atmosphere, we can work out pretty good determinations of the temperature and pressure of that atmosphere.

Surprising, but well established results have already been attained. For example, we know that the atmosphere of the sun is so rarefied that all its hundreds of miles of depth, compressed to the density of common air, would make a layer not more than a foot thick, and that the atmosphere of many of the stars must be still more tenuous.

ONE of the dreams of the spectroscopist has then been largely realized. Our means of interpretation of these cipher messages are advanced beyond even the hopes of twenty years ago.

But the advance has led to new observational demands. Most stellar spectra—especially those of stars redder than the sun—are full of lines—they are like Merlin's book of magic, with its margins written over "with comment, densest condensation," so that only the master's eyes could read the charm. Even for the sun itself, where we have floods of light, and may use the most powerful instruments that can be built, there are hundreds of lines that are "blends" of two or more components, due usually to quite different substances, which are so close together that our greatest resolving power cannot separate them.

In the older days, when we wanted only to know whether there were iron, nickel or calcium in the sun, this did not matter much. If our initial line was confused by a blend, we could usually find plenty of others which were not, and which sufficed to prove the presence of the element. But our present problems demand a careful, detailed study of the position and the intensity of each individual line, and we cannot turn to one to tell us what is concealed by blending in another case.

It is therefore of prime importance now to photograph our spectra on the largest practicable scale. The spectrum of a star like Arcturus is so crammed with lines that if we take the finest photographs of the past generation, showing a spectrum three inches long, with hundreds of lines visible, the great majority of these "lines" are really blends of two, three

or four stellar lines, too close together to be separated on this scale.

Professor Rowland, in his great work at Johns Hopkins thirty years ago, prepared a map of the solar spectrum enlarged from his original photographs which, if the sheets were placed end to end would make the visible spectrum more than forty feet long. With this great scale, much—although not all—of the difficulties disappeared.

The stellar spectroscopist, for many years, has dreamed of having spectra "on the scale of Rowland's map." His dream has not quite come true, but it is nearer realization than he ever dared to hope. To make it come true, even in fact, demands two things. First, the feeble light of the star must be concentrated by a great telescope, so that as much as possible of it may be fed into the slit of his spectroscope. Secondly, the spectroscope itself must be large and powerful. A small instrument, however perfectly constructed, will not suffice. It is well known to students of optics that just as a small object-glass can never give separate images of a close pair of stars, a small prism cannot resolve two closely neighboring spectral lines. In both cases the properties of the light-waves themselves set the limit.

TO get the spectra of which we dream, we must then have a huge telescope and a big spectroscope. The hundred-inch reflector satisfies the first need, and, in designing it, an auxiliary mirror was provided which may be set to reflect the light down towards the south pole of the heavens, so that, as the telescope follows a star all night long, its light is delivered always at the same point. Here it enters a spectroscope which is fixed in position, thus avoiding many complications. The lenses of the spectroscope are of fifteen feet focal length, and the prisms eight inches and more on a side. There are two of them, with a mirror behind to send the light back through them, and the lens again, so that the power of four prisms can be realized.

The elementary student thinks of a spectroscope as a portable instrument, easily carried from one place to another. Even the experienced laboratory worker thinks of its prisms as small, although costly, optical parts, and when he hears of a case placed around the prisms to protect them from changes of temperature, his idea is naturally of something perhaps as big as a waste basket, at the most. But this spectroscope is different. It requires, like others, to have its prisms kept at a constant temperature—for otherwise the spectral lines would shift on the plate during the long exposures, and spoil the photographs—and this case must be electrically heated, by devices connected with a delicate thermostat, so that, if the temperature falls by a hundreth of a degree or so, heat will be turned on to warm it up again. But this time the prism case is a huge wooden box perhaps seven feet square, with doors that open almost wide enough to let in an automobile.

To put the lens and prisms in place is strenuous work, for these valuable affairs are no light load. One of the great prisms, with its mounting, must weigh well on to a hundred pounds, and this has to be held up as high as a man's head, and its carriage slipped into place while the bolts that hold it are set and screwed home. One man alone could do nothing, and it is a hard job for two. A few days ago, the writer saw the thing done by three men—who had to be as active physically as they were competent technically, and all three while at their work were inside the constant-temperature box of the instrument!

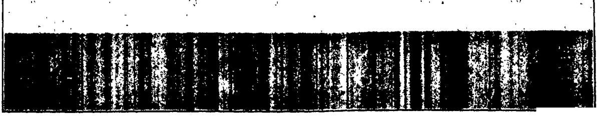
When the apparatus was finally assembled, various adjustments had to be made (for focus and the like) and a good day's work had been put in before the spectroscope was ready to receive starlight in the evening.

Then came the final test—seven hours' exposure upon Arcturus—the observers sitting in a darkened room below the observatory floor, watching through an eyepiece the slit of the instrument, and manipulating the electrical controls so that the star's light was kept steadily going where it was needed. The end crowned the work. The plates, developed the next day, showed a spectrum, running from the violet almost to the green, and twenty inches long. The same region, on Rowland's published map, would be five or six times as extensive; but these have been enlarged from the original photographs, and if the same should be done for the star, the dream of the elder workers would be very nearly true.

Only the brightest stars can be observed with this great power, but with one prism working instead of two, anything brighter than the third magnitude is accessible. This means that stars showing almost all the principal types of spectrum may be studied. A single plate, the result of a night's work, may show far more than a thousand lines. The measurement of them, and the working out of the results, is enough to keep a good man busy for weeks. And so the men whose dreams have come true are happy—they have the chance for more of the work that men like Michelson find "such good fun." When it is through, we will know far more about the conditions which prevail in the stars than we do now. But the satisfaction in the results will not equal the pleasure in the search for the fortunate few who can pursue it.

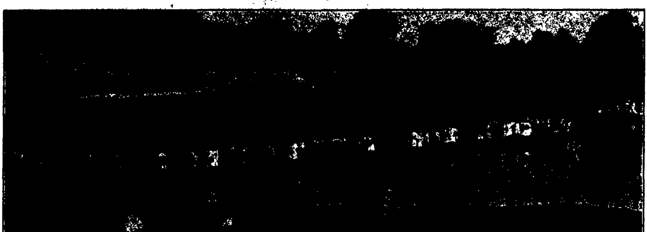
THE fainter stars, which cannot be attacked with these spectroscopes, are studied with small ones—at the other extreme comes an affair that gives a spectrum only an eighth of an inch long—and we can get an intelligible, although of course not a detailed, spectral message from a star that sends us only a millionth as much light as Vega.

Working on the fainter stars has its incidents too. Not ten days ago the writer found one of his colleagues observing upon a faint star so far to the south in Centaurus that the telescope tube seemed almost horizontal. "Come along up," said he. Coming up involved climbing out along the huge frame of the instrument, up a sort of ladder fixed on one side of the huge "fork" which holds the great tube, with the concrete floor twenty feet below, and then swinging out upon the back of the great tube, where the two of us sat—as if on the back of some monster far larger than an elephant—and discussed the universe in the intervals of controlling the instrument.



A CODE MESSAGE WHICH REVEALS A WORLD OF FACTS TO THE PHYSICIST

Various elements in the gaseous layers surrounding the stars absorb the light of certain wavelengths. This light therefore fails to register in the spectrogram, because it simply is not there—it did arrive from the star. The dark lines that result tell the astrophysicist which elements in the star's atmosphere have stopped the light, because he has made similar experiments on artificial light, working in laboratories like the one on the opposite page



Scientifically Designed Golf Clubs

By D. McFARLAN MOORE

WHEN I handled golf clubs for the first time a good many years ago, I immediately complained that they were not properly designed. That is, a golf club is an instrument for striking a ball and as such it should be formed strictly in accordance with the laws of mechanics. But this is not the case with what is today accepted as a typical set of golf clubs. They could very properly be described as glorified "crooked sticks"—such as evidently were used by the first Scotch players. [One exception to this is what is known as the Schenectady putter. The Editor.]

If a mechanical engineer were asked to design an automatic machine for striking a ball with a diameter of 1.62 inches and a weight of 1.62 ounces, he would be considered a very poor engineer indeed if he placed the point of striking one and one-half inches off center. Yet an ordinary driver, for mple, is a machine, or rather a tool, that has just such poor design incorporated in it.

Golf experts have simply learned after much practice the trick of doing "fairly well," with poor tools. If a player now averages about "100" he can easily reduce it to less than "90," simply by using properly designed clubs. Or a beginner can break a "100" with less than half of the practice or expensive lessons now required.

FIGURE 1 is a photograph of the new and properly designed brassie. It is not "off center" at all. It obeys the fundamental laws of mechanics that should be rigidly applied to the design of all clubs of a set; that is, the axis of the shaft must be intersected by the prolongation of the diameter of the ball that points in the direction in which the ball is to travel. Figure 2 illustrates this new principle in elevation. Figure 3 illustrates an ordinary club in the same way. The upper portion of these two figures view the golf ball and club from the direction in which the ball is to go and the lower portions view the ball and club from above.

Common sense and principles of mechanics tell one how extremely defective in principle is the old design as compared with the new. Referring first to Figure 3, it is obvious that the smaller the angle x (which governs the "lie" of the club) the greater the tendency to reduce, at the moment of impact, the angle y; or in other words, to cause the club to twist backwards in the hands. Now referring to Figure 2, we find that angle x is the same, but there is no angle y; and therefore, that greatest bugaboo to the beginner of golf is entirely eliminated.

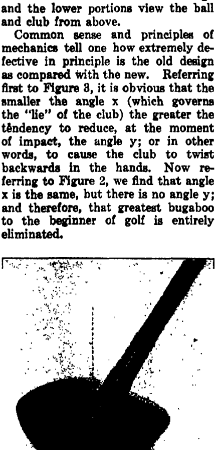


FIGURE .

In this improved brassie the ball is struck with the face of the club at a point where the axis of the shaft crosses the center of the club face, thus realizing the greatest possible efficiency from the stroke

It also is clear now why professional instructors have told us to try to get the habit of unconsciously tightening our grip just before the club hits the ball. Experienced golfers, when getting accustomed to these new clubs, will need to forget this. With the new design this admonition is unnecessary—the disturbing twist has disappeared and the ball is struck so "sweet and clean" that the very sound is exhilarating. When using the old clubs, the very laws of mechanics determine that the pressure of the stationary ball must tend very decidedly to make the shaft of the club revolve backwards in the hands.

IF the angle x was less or eliminated —for example with the shaft straight up, and at a right angle to the ground—the revolving action would be at a maximum. But since you can drive the ball better when standing further away from it, the angle x is necessary and the resultant tendency to a rotary motion in your hands is still present.

But if the shaft of the club is attached to the head in accordance with the principle shown in Figure 2, then the very undesirable and unscientific twisting motion is entirely eliminated, and the club comes as close to scientific design as it is possible to make it.

The mechanical motion is pure and the stroke is almost necessarily clean. The distance which the ball can be driven is much increased and the possible accuracy in direction is far greater.

Although mentally convinced many years ago that such a club design was correct, it was only at a comparatively recent date that I had clubs constructed which very decisively proved their superiority. The first step was to remodel an ordinary brassie as shown

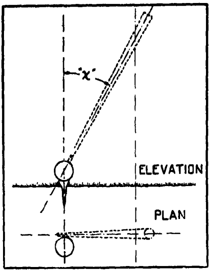


FIGURE 2

Showing how the brassie illustrated in Figure 1 meets the surface of the ball

in Figure 1 on the opposite page.

This was done by retaining the angle of lie x, but moving the axis of the shaft 1½ inches to the left, when viewed from the front. The old goose-neck stepping of the shaft was sawed off. At its lower end the new shaft axis passes directly behind the point on the face of the club where the spherical surface of the ball first meets it.

THERE is no tortion factor to be considered with this new and improved line of clubs but there is a definite inter-relation between each of the clubs of a set as regards length, total weight, balance (head weight), resilience, grip, lie angles, face-loft angles, et cetera. They are the easiest swinging and longest hitting clubs, because there is no uncertain feeling at the beginning of the stroke, and at the end no violent vibration of the club in the hands. With them, every ounce of effective force can be made to count in producing the highest club-head speed just as it approaches the unsuspecting ball.

The muscles of the hands and wrists can do their best, because no strength is lost in attempting to overcome that uncomfortable and wholly unnecessary twisting factor.

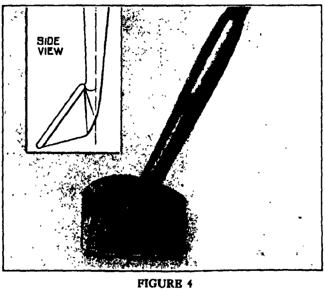


FIGURE 4

A modified mashie, in which the head is not off center. The insert shows a side view of this same club head

When addressing the ball, the feel of the brassie shown in Figure 1 is remarkably quieting. Both its toe and heel avoid going into the air and its sole is settled. Also, one most naturally takes the correct grip on the circumference of the shaft. That is, there is no uncertainty as to whether the under knuckles be revolved to the right or left and no desire to change the angle of the club's face. A club-inspired quiet confidence assists greatly in avoiding errors in turning or changing the angle of lie during the up or down stroke.

Even the beginner generally escapes the humiliating feeling following the missing of the ball altogether, or of dubbing it, and soon finds himself making consistent rounds.

Due to the really perfect balance now possible, the "whip" of the shaft is distinct and most of the best known troubles that beset golfers, including slicing, hooking or pulling, topping, et cetera, disappear.

THE essence of golf is distance and direction. Far greater acccuracy in sending the ball exactly in the direction desired is now possible because the very disquieting factor of twisting is eliminated.

The design of these new clubs permits of far greater strength and better workmanship. They will not only improve your game, but very greatly enlarge your enjoyment because of the absence of perplexing failures.

Golf is a game of delicately adjusted details that have rightly been considered of great importance, but it seems almost astounding that the factor of such prime importance as changing the fundamental principles of golf clubs has not been given proper attention before.

The diameter of the shaft is often made large in clubs of so-called standard design, to help the grip withstand the twist, but it has also been said the less the wood the better, and even the width of the face of the club can be less because less leeway for error is needed as confidence becomes greater.

In principle, at least, most of the foregoing is directly applicable also to the irons. The present-day standard

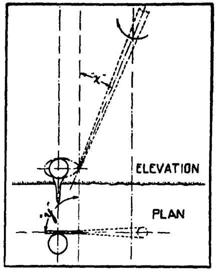


FIGURE 3

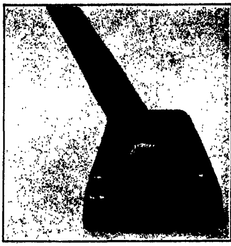
A standard "iron" tends to twist in the hands as shown by the curved arrow

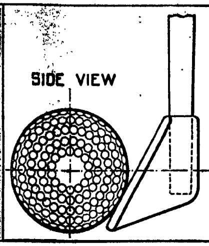
line are all wrong. They sin against the laws of mechanics even more than the wooden clubs, such as the driver and brassie.

An ordinary mid-iron is as much as two inches off center. Figure 4 is a photograph of a very much modified mashie—yet the angle of lie is the same and so is the face-loft angle. When properly used, a mashie always sacrifices distance for accuracy in direction, which nevertheless heretofore required much practice. But with this new mashie the hit is definite. It is like a hammer that hits the nail on the head, not with an off-center blow. If you imagine trying to drive a nail by hitting the nail with only a two-inch projection out of the side of the head of the hammer, you are picturing the action of an ordinary mashie.

ON trial, the mashie, modified almost beyond recognition (Figure 4), proved very satisfactory and led the way to the improved design shown in Figures 5 and 6. By increasing the face-angle from the 65 degrees of the mid-iron and changing the lie-angle and shaft length, the driving iron, cleek, putter, et cetera, are made. And by decreasing the face angle and changing the lie-angle and shaft length, the mashie iron, the mashie, niblick, et cetera, are made. Due to the greater hitting accuracy now possible, there is no need for a greater face width than the two-and-one-half inches shown. Neither will professional "turf digging" be nearly so much indulged in as at present, thus also dispensing with the unpleasant and expensive feature of roughened fairways.

The balanced face of the club shown





HOW IT WORKS

lub is brought in- e ball's surface

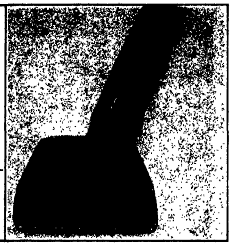


FIGURE 6

The face of one of the newly designed "irons" which can be made in any form

in Figure 6 is an improvement over the very irregular outline of the face of an ordinary iron. In fact, it is simply a fast-moving uniform inclined plane that picks up the ball. Figure 5 is a rear view of the club shown in Figure 6. The transverse holes were made simply to obtain the correct weight. The metal of this head is so distributed that there is no retardation in properly "carrying through" the stroke. The heavier the head of a club, the more difficult it is to control its direction during the downward swing so that the mechanical center of its face will strike opposite the ball's center.

Face indentations can be greatly varied, but the simple parallel grooves shown covering the entire surface have proved adequate.

The longitudinal axis of the shaft must not only intersect the vertical center of the club's face, but must do this at the proper height; that is, at the vertical center of the club's face which is opposite the ball's center. This theory is therefore very different from that advanced for what is today generally accepted as an ordinary set of golf clubs. In the latter case, the shaft is considered as a mere tool to "throw the head of the club at the ball."

The stored energy of the head, which is equal to the product of its mass times its velocity, is supposed to be solely responsible for changing the condition of the ball from a state of rest to rapid motion. That is, the function of the muscles of the arms is not supposed to aid in suddenly pushing the ball forward but merely to produce a rapid speed for the club's head just before the moment of contact. But the average individual requires long practice to reach such a stage of efficiency. However, if to this theory there is added a club design that permits the muscles of the arms to aid directly in urging the ball forward without ruining its direction, a distinct advantage has been gained. That is, with the improved clubs in which the centers of gravity of the heads are in alignment with the ball at the movement of impact, it is possible for a new player to get a reasonable distance and good direction long before he has mastered high club-head velocity.

The face corrugations consist solely of concentric circles, and when the ball is struck, the center of the club head is exactly opposite the center of the ball. The diameter of the head is a little less than the diameter of the ball. Also, the perfectly flat and uniform face enables the player, when viewing it from above, to most easily place it at right angles to the line reaching to the center of the cup, so that as regards direction it makes it the most accurate of all putters.

When a ball is struck with all ordinary clubs, there is a considerable complexity of resultant forces, angles and planes which all affect the ball's ultimate direction, but with this simple disk club, the resultant action is most direct.

A complete set of "center-line clubs" constitutes a decided and radical departure from the long accepted and traditional form of golf clubs, and therefore it is to be expected that some opposition will develop before their use will be universally sanctioned. But the "urge to win" in golf is so great that scientifically correct clubs will fill a large and pressing demand.

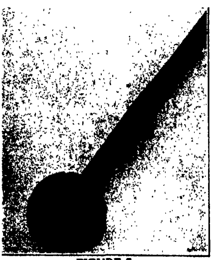
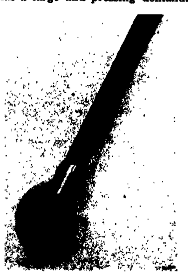


FIGURE 7

An "iron" of the straight-line type, in which the face is nearly perpendicular

FIGURE 7 is a photograph of a straight-line club of the same general type, but its face is more nearly perpendicular to gain greater distance, and it was first machined as a disk. Then the lower segment was removed so that the center of the inclined face would be the same height above the ground as the center of the ball.

Figure 8 shows a putter. Some might describe it as an abbreviated croquet mallet with modifications. Perhaps it is the simplest of golf clubs. It should be noted that besides being a straight-line club, there is no "lie angle" as the term is generally used, because both of the striking faces are parallel to the shaft axis. Nevertheless, since the faces (either one can be used) are circular, the angle of the shaft axis to the ground can be anything the player finds best.



Either side of this circular be used, as they are both

Photographs made specially for the SCIENTIFIC AMERICAN

ELECTRICALLY LIGHTED LOCOMOTIVE

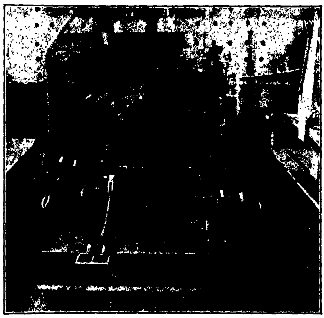
well-known "Ford efficiency" is applied in locomotive ign. This night photograph shows one of the new types

ENGINEER AT THE THROTTLE

This view of the upper part of the cab shows the c controls. Everything is as convenient as in an a

STOKING UP DURING A RUN

The fireman shovels coal and keeps the water at the proper level. In freight trains, the head brakeman rides in cab



THE FURNACE END OF THE BOILER

The door in the center can be opened by hand, by compres air or by foot when the fireman has a shovelful of c

Everyman's Locomotive

During a recent visit to part of the Ford establishment, usually called the River Rouge Plant, we were attracted by the many locomotives which we saw. Our curiosity was soon satisfied, for near the great blast furnaces we found a completely equipped locomotive shop. We do not say factory, for we do not wish to give the idea that the Ford Motor Company is making locomotives for sale. They do, however, make them for their own use on the rails of the Detroit, Toledo and Ironton Railroad Company. We believe certain parts are made elsewhere, but they are few in number and most of the work of production is carried on in this shop. The locomotive required for the service of this railroad is not of the very largest type so it might be called "everyman's locomotive." Two things about the locomotives are very pronounced. The first is the mass of nickel plating, for Mr. Ford is very partial to having everything spick and span and his idea is a good one for he argues that if the nickel-plated part is bright, it is clean. The next point is the fact that the engine is electrically lighted at all the points where troubles usually occur. Through the courtesy of Mr. L. R. Williams, Superintendent of the locomotive shop of the Detroit, Toledo and Ironton Railroad Company, we are enabled to present some "close ups" of the cab which has such a fascination for almost everyone. Mr. Williams has marked the various parts and here is his list: A—headlight switch; B—bright or dim switch for headlight; C—whistle lever; D—air gage; E—gage cocks; F—lubricator; G—gage-cock dripper; H—turret box; I—top water-glass cock; J—water-glass; K—water-glass light; L—throttle lever; M—washout cover plate; N—engine oil can; O—independent brake valve; P—automatic brake valve; Q—reverse lever; R—fire-door air cylinder; S—drip pan; T—fire door; U—hand operating lever for fire door; V—foot operating lever for fire door; W—grate-shaker lever; X—reverse-lever quadrant; Y—aluminum floor; Z—aluminum chair for the engineer; 1A—grab handle for use when mounting cab; 1B—cab curtain.

Are Athletes Machines?

Newly Invented Electric Timing Apparatus Reveals the Science in Running

By A. V. HILL
Foulerton Research Professor of the Royal Society, London; Nobel Prizeman in Medicine

IN a previous article in this journal (April 1926, page 224) I suggested that an electrical method of timing runners, not only over the whole extent but throughout the course of a race, might be of considerable interest, not only to athletes and the sport-loving public but to those who are studying athletics from the scientific standpoint. During the tenure of a non-resident lectureship in chemistry at Cornell University I have recently had an opportunity of testing this suggestion in practice, with results which have greatly exceeded my expectations.

The apparatus employed is shown in Figure 4. It consists of a series of coils placed parallel to the track at measured intervals. Each coil consists of 200 turns of insulated copper wire, Number 26, the coils being connected in series to a Moll moving-coil, mirror galvanometer of very short period (0.8 second), placed in a room in the pavilion. The movements of this instrument, adjusted for aperiodicity, are recorded photographically on moving bromide paper in a camera of the type constructed by the Cambridge Instrument Company for use with the electrocardiograph. Time marks are made by a metronome or pendulum which cut off the light momentarily at suitable intervals.

THE runner (Figure 2) carries a magnet around his waist or chest: the one shown is merely a hack-saw blade with its teeth ground off, and magnetised in a solenoid. As the runner comes up to a coil, the induction from the magnet through the coil increases, reaches a maximum when he is in its meridian, and falls off again as he passes on. The current induced in the coil is recorded on the galvanometer.

The record (Figure 1) is not a true picture of the current; to obtain that, an instrument of much shorter period (for example, the string-galvanometer) would have to be employed. If, however, the runner is reasonably close to the coil, so that his angular velocity is great, the deflection is very sharp and the point of the curve represents with considerable accuracy the moment at which he passes the meridian of the coil and runs toward the next coil.

THE AUTHOR

This informal picture was taken at Cornell University, where Dr. Hill has been conducting research on athletes

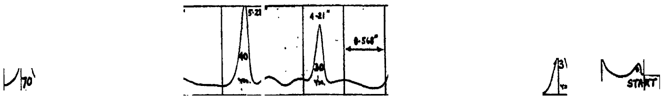
The magnet is no hindrance to the runner, and the system of placing the coils parallel to the track, instead of around it as suggested in my previous article, is much more convenient. For a permanent installation the best system would probably be to fix the coils with their planes horizontal, above the track, at a height, say, of seven feet, and to employ a vertical magnet on the runner. Six or more such coils could be placed side by side, and connected with the six strings of a "sound-ranging," string galvanometer, so that six runners could be recorded graphically in the same race on one strip of bromide paper. Such an installation, employed, for example, in the final heat of the 100-meters race at the Olympic Games, would provide results of quite exceptional interest.

To record the start, an electric switch is opened at the same moment as the signal "go" is given. This breaks the primary circuit in a transformer, and a current is induced in the secondary. To make the record smaller and more sudden this induced current is put through a second transformer, and the second induced current runs through the galvanometer. The upstroke of the starting signal is extremely sudden and can be read to 0.002 second if desired. If it were required to make the upstroke absolutely simultaneous with the order to start, the electric switch could be included in the pistol. Figure 3 shows the starting switch in use, together with the two transformers on the bench.

IN the record of Figure 1 the coils were placed at 1, 3, 6, 10, 15, 20, 30, 40, 50 and 70 yards, respectively, from the starting point, and the corresponding times are 0.64, 1.05, 1.51, 2.03, 2.61, 3.18, 4.21, 5.23, 6.24 and 8.27 seconds. The light was cut off momentarily every 0.284 second, leaving a little gap in the curve; lines have been ruled in through every alternate one of these gaps, from which the times are measured up. The runner in this case ran as fast as he could from the start.

In Figure 5 another record is given, in which the subject (a broad-jumper) ran as though he were going to carry out a broad jump, the coils being arranged at 1, 3, 6, 10, 15, 20, 25, 30, 35 and 40 yards, respectively. The object of this trial was to ascertain how far he needed to run in order to attain his maximum speed. In this particular run the maximum speed, 9.7 yards per second was reached in 30 yards.

The consistency with which records can be reproduced by a man in train-



RECORD OF A SEVENTY YARD DASH, AUTOMATICALLY MADE WITH THE ELECTROCARDIOGRAPH

FIGURE 1: *The start is at the right. The details which the record reveals are explained in the text of the article*

ing is remarkable. The subject of Figure 2 ran four times in the same afternoon, at intervals of a quarter of an hour, with results given in the following table:

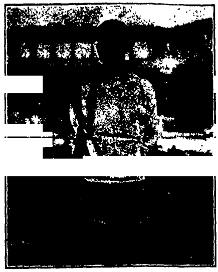
Time: Seconds										
(1)	0.67	1.09	1.58	2.12	2.74	3.30	4.38	5.43	6.51	7.56
(2)	0.63	1.07	1.56	2.10	2.72	3.28	4.36	5.42	6.51	7.58
(3)	0.62	1.04	1.54	2.08	2.71	3.27	4.36	5.43	6.53	7.60
(4)	0.67	1.07	1.56	2.10	2.70	3.27	4.35	5.41	6.48	7.50
Mean....	0.65	1.07	1.56	2.10	2.72	3.28	4.36	5.42	6.51	7.56

The average difference between the mean and the observed time for any distance is only 0.014 second, which surely is a tribute to the consistency of the human machine.

THE amount of energy expended in fast running is very great, as was emphasized in my previous article. Quite an ordinary performer may finish a 100-yard sprint with an oxygen debt of six litres; in other words he will require six litres of oxygen to carry out the combustions necessary for recovery from his effort. One litre of oxygen used in burning glycogen (the chief—perhaps the only—fuel of muscular exercise) liberates energy to the extent of 15,800 foot-pounds, so that nearly 100,000 foot-pounds of energy may be used as the result of running 100 yards at top speed; probably in a first-rate athlete considerably more.

What is done with this energy? What resistances are the muscles overcoming? The air resistance, although not negligible, is fairly small, and cannot account for more than a fraction of the energy, since running at 10 miles per hour into a 10 miles per hour head-wind is nothing like so energetic as running at 20 miles per hour in still air. There is only one possible answer to the question: the resistance is mainly in the body itself, chiefly in the muscles.

In the last few years considerable research has been devoted to the "viscous" properties of muscle. If a muscle shortens slowly it does much more external work than if it shortens quickly, under otherwise similar conditions. There is a resistance, increasing with the speed, inherent in the muscle-substance itself. This acts as an automatic brake, preventing an animal from moving too quickly and so developing such high speeds in his limbs that they would be apt to break under their own inertial stresses. This resistance, in man, appears to be proportional to the speed at which the muscles shorten, and so is governed by the same rule as would hold for the case of simple viscosity, in a system deformed under a force externally applied. In such a system the energy wasted would be proportional to the speed of deformation.



RUNNER WITH MAGNET

Figure 2: The magnet is simply a strip of steel tied across the runner's waist

In muscles the effect is not really simple viscosity; it is due rather to molecular hysteresis in a physico-chemical system carefully adjusted by nature to the greatest speed at which it is expedient for the animal to move, in view of the limited strengths of his various structures. The effect, however, is similar to true viscosity, and obeys the same equations, so that we may work out simple formulae for the case of a man running, which fit the facts very closely.

If we assume that an athlete (mass M) begins to propel himself forward with a constant force (F) from the moment he starts, against a resistance which is α times his speed, then it can easily be shown that the distance y covered in time (t) should obey the equation:

$$y = \frac{F}{\alpha}\left[t - \frac{M}{\alpha}\left(1 - e^{\frac{\alpha}{M}t}\right)\right]$$

It is possible to fit this equation to the observations with a high degree of accuracy. Taking F/α as 9.43 and M/α as 1.090, and allowing an absolute latent period in starting of 0.12 second, the distances calculated for the observed mean times in the above table compare with the observed distances as follows:

Observed	1	3	6	10	15	20	30	40	50	60
Calculated	0.97	2.99	6.05	10.07	15.20	20.10	29.9	39.8	50.0	59.9

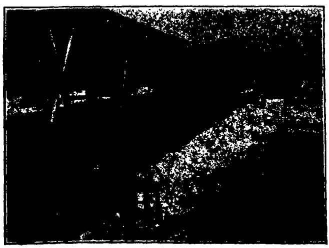
THE average difference between observed and calculated distance is 0.086 yard, that is, about three inches. No better agreement could be expected. It is obvious that in a short race we may regard an athlete as being propelled by a constant force, and resisted by a force proportional to his speed. Thus, like a raindrop falling through the air, he rapidly attains a certain limiting speed depending on the ratio of propelling force to resistance; and this speed will remain constant until other factors, for example, fatigue, cause it to fall off.

The value of F/M can be calculated from F/α and M/α by division. On dividing further by g (10.73 in yard-second units) we obtain the value of the force exerted, in terms of the weight of the man. In the above case the propelling force is 0.806 of the runner's body-weight. The highest value hitherto observed is 0.92, the lowest, 0.51.

Taking 0.85 as a typical value, this implies that an athlete, running 100

RECORDING THE START

Figure 3: An electric switch held in the hands of Jack Moakley, famous coach, is closed when the word "go" is given



THE WIRE COILS

RECORD OF BROAD JUMPER

FIGURE 5: *How far must a broad jumper run in order to attain his maximum speed? Thirty yards, says the record. See text of the article*

yards at top speed does enough mechanical work to lift his body 85 yards into the air—about one third the height of the Woolworth Building in New York City. No wonder that he requires six litres or more of oxygen to recover!

Assuming his weight to be 150 pounds, the mechanical work done is about 38,000 foot-pounds, while the oxygen debt of six litres corresponds to 95,000 foot-pounds of total energy. Thus, reckoned in this way, his mechanical efficiency works out at 40 percent, a very high value, which to those acquainted with recent muscle-physiology will indicate that practically the *whole of the initial energy in muscular contraction may be transformed into mechanical work*, the remaining 60 percent appearing as heat in recovery.

We see therefore that the behaviour of an athlete, up to the stage when his velocity begins to fall off under fatigue (a matter still to be investigated) can be described with the aid of three constants and an equation. These constants are:

(1) The absolute value of his latent period, during which the starting signal is going in to his brain and is being signalled back to his muscles. This quantity is usually of the order of 1/10 second and is relatively unimportant. (2) His propelling force, which is usually about 0.85 of his body weight, but may vary fairly widely on either side. (3) His coefficient of "viscosity," defined by the quantity α/M, which is usually about unity, but again may vary fairly widely. Given these constants, the behaviour of the runner is defined, and the differences between different runners can be described in terms of their constants.

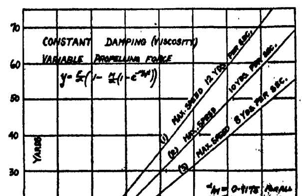
For example, in Figure 6 the distance-time curves of three runners, with constant "viscosity" but variable propelling force, are given. In Figure 7 the converse case is taken of constant propelling force and variable "viscosity." The curves explain themselves. In every case we notice that the maximum speed is practically attained in 20 or 30 yards, and that if the straight part of the curve be produced back to cut the horizontal axis, it meets it at about one second. In this sense there is a total lag in starting of about one second.

By simultaneously varying both propelling force and viscosity, some interesting calculations can be made. In the following table, for example, are three runners who can all run 40 yards in five seconds, but who differ in respect of their "constants." Number 1 is comparatively weak, F is only 0.775 of his weight, but he is very skilled in his movements and his "viscosity" is low, so that α/M is small, namely 0.7775. His maximum speed is high, 10.70 yards per second, but he takes some time to attain it. Number 3 on the other hand is very powerful, F is 0.985 of his weight, but he is clumsy and "viscous," $\alpha/M = 1.079$, and his maximum speed is only 9.81 yards per second, although he attains it rapidly. Number 2 is intermediate: his constants are 0.873 and 0.9175, respectively, and his maximum speed is 10.21 yards per second. Their distances for various times are as follows:—

Time: Seconds		0.5	1.0	1.5	2.0	3.0	5.0	7.0	10.0
Distance: Yards	(1)	0.92	3.26	6.57	10.53	19.6[illegible]			
	(2)	1.02	3.53	7.00	11.0[illegible]	[illegible]			
	(3)	1.11	3.81	7.42	11.5[illegible]				

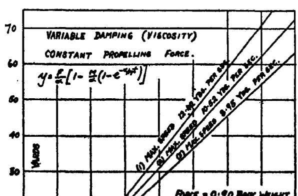
We see that for the shorter distances Number 3 is the best man, for longer distances Number 1; and it is worthy of note that Number 1 is exerting only 89 percent as much energy as Number 2 in running the same distance, and only 79 percent as much as Number 3, so he will tire correspondingly slower.

Enough has already been said to indicate that matters of very great scientific interest can be found in the performances of that extraordinary machine, the human athlete.



DISTANCE-TIME CURVE OF THREE RUNNERS

FIGURE 6: *With constant viscosity but variable propelling force*



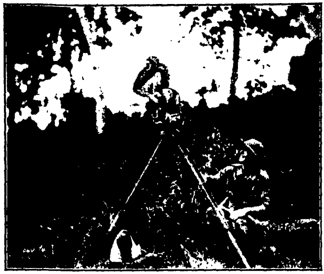
ANOTHER DISTANCE-TIME CURVE

FIGURE 7: *Conditions are the converse of those in the curve at left*

All photographs courtesy Paramount Pict....

THE PHOTOGRAPHERS AT PLAY

ck and Major Cooper with one of the tigers they photographed and then killed



THE STAR COMEDIAN

"Bimbo," the gibbon comedian, is on the camera sack and some native actors are watchi

Motion Pictures Record Jungle Life

Intrepid Cameramen Brave Many Dangers to Produce a Film Epic of Siam

By A. P. PECK

EQUIPPED with two motion picture cameras and two tripods, two men set out from New York to make a film in the jungles of Siam. Many months later they returned with thousands of feet of exposed film, which film, when cut and edited, was destined to make a unique place for itself in the film annals of the country. The picture was titled "Chang" and as such is now enjoying a long and popular run.

When the writer first saw a pre-release showing of the picture, he was of the opinion that much "trick" photography must have been resorted to in order to obtain the marvelous effects depicted. With this in mind he interviewed Ernest Schoedsack, who, with Major Merian Cooper, penetrated the fastness of the jungle to record on photographic film a simple yet fascinating story of the struggle of the natives of Siam against wild beasts and the wilderness. The results of the interview were as surprising as they were interesting. According to Mr. Schoedsack, he and Major Cooper took with them nothing in the line of apparatus that would enable them to take "trick shots."

"THERE were no trick arrangements used," said Mr. Schoedsack. "The only requirements for results, aside from the usual knowledge of photography, seemed to be hard work and then more hard work. Photography in the tropical jungle proved to be vastly different from that in the studio. We met with conditions that were not to be found in any other locality and the overcoming of these involved the hard work that I just mentioned. Consider working in a country where the days are hot, the sunlight brilliant, the majority of the colors photographically dull, the mornings and late afternoons invariably misty, and you will have an accurate picture of the photographic difficulties that we had to overcome."

The story of "Chang" briefly told is as follows: The members of a native family, more venturesome than the rest, have left the comparative safety of the village and started to build a home for themselves in the jungle, far removed from their companions. Here they encounter many difficulties. Wild animals kill and devour their stock and the man of the family builds traps in an endeavor to rid the territory of the predatory beasts. During one of the hunts a baby elephant is captured and is tied to one of the posts supporting the house. Soon the mother elephant appears on the scene and in her rage at the treatment of her baby, she proceeds to demolish the home.

AT THE WATER HOLE

This close-up of a wild tiger was filmed from a camouflaged shelter

THE native finds that the "great herd," a band of wild elephants that has not been seen for generations, is returning. He warns the villagers. Soon the herd appears and crashing through the village, razes it completely. The natives band together, build a sturdy *kraal* in the jungle and start a drive on the elephants. Using their native cunning to prevent a stampede, they gradually drive the animals closer and closer to the trap. Soon the elephants are captured and the process of training them for useful purposes begins. The venturesome native and his family then return once more to the wilderness, rebuild their home and begin again the grim battle with nature.

From this description it can be seen that there are innumerable possibilities present for the photography of wild animals in their native haunts, and Schoedsack and Cooper made the most

of them. Scorning the use of tame, trained animals whose actions were likely to be less natural than those of the wild beasts, they set to work to develop methods of photography that would produce the desired results and still have a certain element of safety in them. Some examples of the types of photographs taken will serve to show the ingenuity displayed.

DURING one of the hunting sequences, two natives were pursued by a tiger, which chased them up a tree. Sensing a chance for an unusual "shot" in this connection, Schoedsack built a light platform in a tree 13 feet above the ground. Taking his camera to this perch and mounting it so that the lens pointed straight down the trunk of the tree, he stretched out on the platform beside the camera ready to crank. In a nearby tree was Cooper armed with a rifle for use in an emergency.

The native beaters then chased a tiger to the vicinity of the tree in which the camera and cameraman were ensconced. Schoedsack started to crank and drew the attention of the animal. The latter looked up, caught sight of the human being in the tree, and started to circle round. Everything was going fine and the camera was recording an excellent picture of an angry tiger. Suddenly the beast took it into his head to try to get the man in the tree. Accordingly, with a single bound he fastened his claws in the trunk and frantically attempted to reach the platform. Calmly the cameraman continued to crank. Cooper was ready to shoot, but Schoedsack called to him to hold his fire as the tiger was ready to drop back, and surely enough, he did just that. After the excitement was over and the tiger had been killed, measurements showed that the beast's claws had left marks on the tree trunk 11 feet from the ground—only two feet from the platform.

For the filming of the elephant herd, a pit was dug. This measured about five feet square and seven feet in depth. It was roofed over with heavy logs, and a low turret of the same material was built in the center. This projected several inches above the level of the roof of the pit and served to protect the camera, to allow the lens to project a few inches above the ground level, and to provide a space for the cameraman to view the action. The logs forming the upper part of the turret were cut away so as to give more room for the camera and still not project too far above the ground. This construction, of course, weakened the top, and Mr. Schoedsack told the writer that he spent many anxious moments in the pit.

THE ELEPHANT STAMPEDE

Crushing everything in their path, the elephants were photographed as they devastated a native village

After the pit had been completed and the cameraman and camera were in place, the natives started to drive a herd of wild elephants through the jungle. They had to exercise considerable skill in doing this, as the herd had to be driven directly over the covered pit. Finally the cameraman saw the animals coming and started to "grind." At a terrific gait they approached the shelter and thundered over it. Bits of dirt and bark from the logs sifted through and added to the discomfort of the cameraman. After passing over the pit, several of the elephants turned and started back. The turret had been weakened by the passage of the herd, and when one of the returning elephants struck a certain spot in the back of the projection, it gave way. Luckily, however, the animal's foot was not caught and he proceeded on his way, after showering Schoedsack with splintered fragments of the broken logs.

In the course of the work recourse was had to other pits and camouflaged shelters. These were erected on or near animal trails through the thick jungles, and often the cameraman had to wait for hours in them until a chance came for a good shot. The shelters placed near water-holes were especially productive of good results. Some excellent photographs of wild animals at close range were obtained in these locations.

IT is interesting to note that no telephoto lenses were used in the filming of this picture. All of the photography was done at close range. One of the reasons for this was the fact that the use of telephoto lenses, while it has advantages, has many disadvantages. For example, with a long-range lens, the field of vision is restricted. Also, definition is not always

AT PEACE WITH THE WORLD

A native village on the edge of the jungle in Siam, typifying the quiet, simple life of the inhabitants

AFTER THE STAMPEDE

The same village shown at the left, after it was laid to waste by a herd of wild elephants

SETTING A SNARE

This photograph is typical of the many instructive scenes in "Chang," showing the life of the Siamese

MAKING A DEADFALL

Primitive materials and methods are used. The "spikes" are sharpened sections of bamboo, lashed to logs

all that can be desired when a lens combination of this type is employed.

During the 14 months that the cameramen spent in the jungles, there were innumerable battles with the wild beasts. Many of them had to be killed either during the action that was being photographed or afterwards. At all times the men carried guns and knives for their own protection, and these were never idle for any great length of time.

For a little comedy relief in the otherwise serious picture, the producers e use of a natural-born humorist, a white gibbon. The antics of this animal, caught by the ever-watchful camera, provided many moments of laughter which would be the envy of any human comedian.

In the performance of his role, "Bimbo," the gibbon comedian, exhibited many of his natural characteristics. For example, at one time he was running through the jungle with a rope that was tied around his neck trailing after him. To prevent the rope choking him in case it became caught, Bimbo held it tightly in one "hand."

A FEW small monkeys were also filmed. Mr. Schoedsack said that the sequence in which these little fellows were used was one of the most difficult parts of the whole picture to film. This was true because the camera had to be placed so close in order to get the desired results that the animals were frightened. Also, the monkeys, when placed in the sun where photography was possible, would insist on going to sleep.

The trials and tribulations of the cameramen were not confined wholly to the animals with which they had to deal. Photographic conditions were of a peculiar variety. When the sun was shining brightly, and in an ordinary climate the tendency of the photographer would be to "stop down" or use a small diaphragm opening, the photographers in Siam found that it was necessary to work "wide open." This over-exposured the film, but the ultimate result, obtained by using "soft" developer, was a negative of fine definition. This process had to be used because of the drab nature of many of the objects being photographed.

Because of the atmospheric conditions encountered in Siam, the film that was to be used had to be loaded in the camera magazines within a few hours before it was to be exposed. Up to that time the film had to be kept in sealed, air-tight containers. Because of this requirement, a "changing bag" had to be employed for loading the magazines. This consists of a light-tight cloth bag provided with two holes for the arms. These holes are closed around the arms by means of elastic bands. To use this bag the material to be handled is placed within, the arms are inserted and the work carried on without the benefit of sight. Imagine groping in the dark in this way when the temperature is ranging around 110 degrees, Fahrenheit.

AT CLOSE RANGE

A section of the film where the tiger is depicted climbing the tree in which the camera is located. The tiger's head completely fills the "frames"

TO be sure that the film was amply protected from the humid atmosphere, that which the photographers took with them was packed in the following manner: The film was in 400-foot reels, ready wound for the type of magazines used. These were placed in standard 400-foot cans, sealed with adhesive tape, and this can in turn placed in a 1000-foot can. The edges of the latter were soldered. Then, when ready, the outer can was opened with a can opener, the smaller one placed in the changing bag and the work carried on. When on location, Schoedsack found that he would soon run out of film. Accordingly, he dispatched an order to one of the largest film manufacturers in the United States, giving definite orders as to the method of packing. When the film finally arrived it was packed in 400-foot cans only and these were soldered! Now, 400 feet of motion picture film fit snugly in a 400-foot can. To get at this film it was necessary to manipulate a can-opener inside the changing bag, spoiling many feet of film with the blade. The discomfort of the photographer can be imagined when the possibility of cuts from the jagged tin, together with the effect of perspiration on these cuts, is considered.

However, all difficulties were overcome and about two years after the venture was started, the producers had the satisfaction of seeing their film received with great acclaim.

¶ *Another "talking movie" has made its appearance and is now being produced commercially. Its technical details will be described at length in an article in our next issue.*

All photographs courtesy of Onondaga Litholite Company

THE MAIN PATTERN SHOP

Wood patterns for moulding stone require the same equipment and practically the same care in making, as for iron

WHERE SPECIAL MODELS ARE BUILT

Metal patterns and special moulds are necessary wher finished details require more elaborate and finer treat

THE CASTING FLOOR

THE AGITATOR AND POURER

Stone Cast Like Iron

A study of the illustrations on these two pages reveals a striking similarity to the different steps in production in an iron foundry. Yet what you see is not iron—it is stone; stone cast and finished in almost the identical way that iron is handled. With this in mind it is interesting to follow through the process of producing cut, cast stone. Because of the necessity of having a flexible mixture, one part of cement is used to three and one half parts of marble or granite aggregate, with eight gallons of water to one bag of cement. Three sizes of aggregates are used —the largest screening through a one half inch mesh. After careful measurement, the batch is mixed for four minutes and is transferred to the agitator and pourer, where it is continuously mixed until the last is passed to the mould. This entire operation takes about ten minutes. The excess water which makes the batch thin enough to flow freely and fill the recesses of the mould, percolates off through the sand, leaving all the cement in the cast. Enough water is thus voided through filtration to give a resultant ratio of three and one half gallons of water to 94 pounds of cement. Twenty minutes after pouring, the cast has settled and become firm enough to trowel, and after 48 to 72 hours of curing in the sand, the stone is hard enough to shake out and pile, the moulding sand adhering to the cast to prevent too rapid curing. After two weeks of curing, the product is ready for me-

A MECHANICAL GRINDER

nice is being ground in a manner identical with : a machine shop. Carborundum wheels are used

CARBORUNDUM SAW

This is not lumber that is being cut, as you fied in thinking—it is stone that has been m

TRIMMING AND FINISHING

Hand finishing with pneumatic tools gives a surface which so closely resembles natural cut stone, both in appearance and durability, as to almost defy detection by observation

ARTISTRY OF A HIGH ORDER

The ornament appears to have been carved from a solid block

chanical finishing. Tests show that this method produces a concrete which runs high in compression strength and low in absorption of moisture. While cut, cast stone is not cheaply produced, because high-grade aggregates and considerable skilled labor must be used, there is a decided advantage in the facts that it is always uniform and that a wide selection of varieties in textures and colors is available. In fact, were it not for the saving made possible by moulding stone to approximately the shapes required, thereby reducing the labor of cutting and finishing to a minimum, it would be prohibitive in price. The use of ornaments and ornamental stone in modern buildings has increased of late years with the diversity of the styles of architecture developed, more especially because of the flexibility of design afforded by reinforced structures. So it is seldom that a building is now erected without the use of such artificial material. The many advantages of the use of cut, cast stone over similar ornamental objects carved by hand from solid blocks of rock are quite obvious when the entire situation is considered. In the cut, cast stone system, some of the advantages are as follows: Hooks for lifting and moving the heavier pieces are cast in the object. The larger casts can be made hollow so that the ultimate weight is reduced. Large columns can be made hollow, yet with steel reinforcement, they are as strong as solid columns would be. Conduits for electric wiring can be cast in the objects, eliminating the necessity of future boring. Where the stone object is to be suspended from structural steel, the necessary holding bolts are cast right in the stone. Furthermore, duplicates of ornaments can be made cheaply, using the original patterns.

Photographs courtesy General Electric Company

THE GIANT OF BROADCASTING

Radio's Goliath

Latest High-powered Type of Vacuum Tube Stirs the Ether with Tremendous Force

By ORRIN E. DUNLAP, JR.

THREE outstanding engineering achievements destined to be recorded on the pages of history as 1927's contribution to the advance of radio are the transatlantic talk-bridge, the electrically operated receiver, and last but not least the 100-kilowatt transmitting tube introduced at station WGY, Schenectady, New York.

This enormous tube, the Goliath of broadcasting, mounted in its water jacket and ready for use, stands seven and one half feet high and can hurl more energy into the emptiness of space than the eight tubes, rated at 20 kilowatts each, which it replaced in WGY's transmitter. It weighs 100 pounds or one pound per kilowatt!

RESEARCH engineers who delve into the mysteries of the ether in an effort to improve wireless transmission and reception, are delighted with this powerful scientific ally which creates mighty waves in space and enables investigations with power up to 500 kilowatts or even more. The radio men in the laboratory of the General Electric Company, where the tube was developed, explain that the 100-kilowatt bulb is utilized as a radio-frequency amplifier, fulfilling in the transmitter a use comparable with the radio-frequency amplifier stages in most radio receivers. They point out that in the receiving system a feeble high-frequency oscillation intercepted by the antenna excites the radio-frequency amplifier tube, which intensifies the incoming impulses, giving them greater power to actuate the detector. In the transmitter, the output of one 20-kilowatt tube is amplified by the 100-kilowatt tube.

The tungsten filament in the big tube is eight feet long and about as large in diameter as the lead of a pencil. The filament contains two ounces of tungsten or approximately 750,000 times as much tungsten as the UV-199 type of tube used in some receiving sets. A spring, which resembles that used on an ordinary screen-door, supplies the several pounds tension necessary to keep the filament straight. Eleven horsepower or six and three-quarters kilowatts are required to heat the filament, which is equivalent to the electric power used to light 170 40-watt incandescent lamps.

The wires carrying the current to the filament must be as large as a lead pencil and the terminals attached to the wires are similar to those common in heavy switchboard construction. The tests disclosed that the high-frequency output of this tube, if utilized to supply power for 40-watt lamps, would light 2500 of them. The engineers call attention to the fact that in present-day dry-battery operated receivers, the power tube supplying the loudspeaker furnishes 11 watts of undistorted power for musical reproduction, while the 100-kilowatt giant supplies 400,000 times as much undistorted power.

An entirely new structural design had to be devised in the research laboratory in order to provide the necessary strength and durability. Outside of its water jacket, the tube is five feet high. Two thirds of its height consists of a copper envelope, four inches in diameter. The metallic envelope is called upon to serve a double purpose. It not only contains the elements of the tube but is, itself, the plate or anode of the device. The upper third of the tube is made of glass, through which the filament leads and the grid lead find insulated entrance. The glass bulb is 22 inches long and four inches in diameter and it is sealed to the spun-out end of the anode cylinder or copper envelope by a machine process. This is done in such a way as to make the junction of glass and copper mechanically strong and vacuum-tight.

TWO copper cables of a size capable of carrying a current of several hundred amperes act as the leads and are connected to tungsten rods, which in turn pass through a pinch seal. These rods serve as inner filament leads at the filament ends. Six lengths of tungsten wire, each about 16 inches long, connect to each of the inner leads, forming six parallel filament spans. These pass within the grid and, turned at angles, meet at a common point at the filament spring-suspension in the lower end of the tube.

The grid, within the copper envelope,

is cylindrical and has an over-all length of three feet, five inches. The grid frame is a most ingenious structure of molybdenum and tungsten. Bracing, of the type common in steel bridge and tower construction, is employed in the design of the frame to provide maximum strength with a minimum of metal. It is important that sufficient strength and rigidity be provided to prevent short circuits caused by swaying or sagging elements. A minimum

THE NEW TUBE
The young lady holds a detector for comparison with the giant tube

of metal in the grid structure facilitates exhaust of the air and minimizes the possibilities of gas evolution. The grid connection inside the bulb is brought out through an arm part way up the high-tension glass bushing to a flexible outside grid terminal.

Those who worked on the development of the tube explain that the degree of vacuum is as important, in its way, as the steam pressure is to a steam boiler. To guard against failure caused by high pressure increases which would be disastrous, a pressure gage, or more properly, an ionization gage, is attached to the big tube.

This gage is in the form of a special three-element vacuum tube, and in appearance is very much like an ordinary receiving detector or amplifier. It is sealed to the large tube and connections to filament, grid and plate are made from the pressure-indicating device to the operating panel. The gage operates on the principle of the ratio of ionization by collision with electrons, to the pressure or amount of gas present.

A new type of water-cooling jacket was introduced with the tube to provide uniform water flow around the anode in order to prevent unequal heating. It consists of an ordinary water-jacket with an inner flexible jacket which directs the cooling water past the anode.

The giant is now being operated as a plate-modulated power amplifier on WGY's transmitter where, due to the limitations of the circuit, the output is normally held at the comparatively low value of 50 kilowatts. Nevertheless, the engineers report that the limitations of the broadcasting system are not preventing them from securing valuable operating data on the Goliath of radio.

It was not many years ago that the arc, spark and high-frequency alternator dominated the field of transmission and it was not until the World War that the vacuum tube began to prove its utility as a means of producing electrical oscillations to set the ether in vibration. Since that time rapid advances have been made in the development of tubes for transmission purposes so that today, in commercial coastal stations, on board ship and among the thousands of amateurs, the spark is obsolete, with the more efficient vacuum tube in the regal position in transmitting circuits.

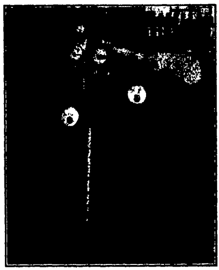
Not to be outdone by a broadcaster of entertainment, the Navy Department has installed an 80-kilowatt equipment, said to be the largest vacu-

INSIDE THE TUBE
The letters designate the following parts: A, ionization gage; B, filament lead wires; C, grid lead; D, high-tension bushing; E, glass junction to copper anode; F, anode seal; G, securing flange; H, copper anode; I, filament pinch seal; J, grid supporting clamp; K, molybdenum inner filament leads; L, tungsten grid structure; M, parallel filaments; N, spring support for filaments; O, quartz support and insulator; P, spacer disk

um-tube transmitter in the world, at the naval radio station at San Diego, California, for communication with Washington and the Far East.

This installation, which sounds the death knell of the old arc transmitter long popular in the Navy, was not designed for telephone use but for radiotelegraph communication, using code which may be sent at the rate of 100 words a minute or about twice as fast as the average conversational speech. The apparatus is said to be four times as powerful as any other vacuum-tube transmitter employed by the Federal Government and it is capable of radiating about 80 times as much electric energy as the ordinary radiophone broadcasting station rated with a 1-kilowatt output.

So powerful is this San Diego installation, with its six-phase vacuum-tube rectifier furnishing direct current

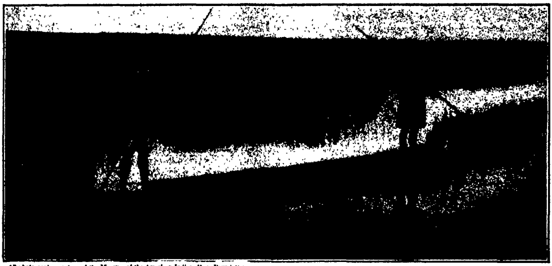


THE TUBE'S BASE
Some of the water tubes as well as meters for checking operation

at 15,000 volts, 7.5 amperes for the plates of the oscillator and amplifier tubes, that it can communicate directly with station NSS, at Annapolis, Maryland, with the Hawaiian Islands, with Japan and with battleships and destroyers anywhere on the Pacific ocean.

The alternating current is first stepped up to a high voltage by means of a transformer, and then, passing through six kenetron tubes, is converted into direct current. A suitable filter, consisting of condensers and a reactor, is used to smooth out the "ripple" in the rectified current. For the transmitter proper, the master-oscillator power-amplifier circuit is utilized in conjunction with a "tank" circuit to insure the elimination of harmonics from the radiated output, so that interference will not be created for broadcast listeners. The master oscillator uses a single tube. which generates the radio-frequency power to be fed into the power amplifier. The latter consists of several pairs of "push-pull" units operating in parallel.

The first transmitters used at the naval stations were of the spark type, which radiated a damped wave. These were replaced by arcs and high-frequency alternators, which were a great improvement and gave greater effectiveness in communication, because they radiated continuous or undamped waves. Then came the vacuum tube as a means of setting the ether in vibration.



All photographs courtesy of the Museum of the American Indian, Heye Foundation

WITH DUGOUT CANOE AND POLES

Two Seminoles in the swamps of the Everglades of Florida. Modern reclamation methods spell the doom of the free, wild life of these American aborigines

The Conquest of the Everglades

Slowly, but Surely, the Seminoles of Florida Are Becoming Peaceably Civilized

By ARTHUR WOODWARD

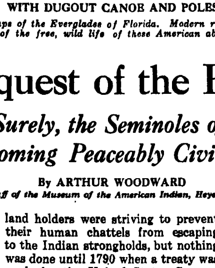
Of the Staff of the Museum of the American Indian, Heye Foundation

SUB-DIVISION methods, and the loquacious tongues of chamber-of-commerce secretaries are at last accomplishing by peaceful means that which the United States Government failed to do 85 years ago by the use of guns and men; namely, the subjection of the proud and freedom-loving Seminoles who dwell within the depths of the swampy Everglades in Florida.

Seminoles, "Separatists" the name means, and separatists they have ever been in the true sense of the word since the first bands of those peculiar folk left the parent tribal body in Georgia, about 1750, and took up residence as a distinct tribal unit in Florida. Originally they were of what is known as Muskhogean stock, members of the Lower Creek towns, and their history has been one of turmoil and sorrow. First it was trouble and dissension with their own kind, and later, after their emigration, with the white man, particularly the Americans.

DURING the days of Spanish rule in Florida, prior to 1819, the Seminoles became involved in their first real war with the United States. The primal cause of this disturbance was the wrath of the Georgia slave holders against the Seminoles who had consistently welcomed to the swamps the run-away slaves of the whites.

Even as early as 1776 the Georgia land holders were striving to prevent their human chattels from escaping to the Indian strongholds, but nothing was done until 1790 when a treaty was made by the United States Government with the Creeks, who agreed to aid in the capture and return of all escaped slaves, but nothing was done. In 1810, the Georgians decided to take matters into their own hands, the Government not having functioned, and there ensued a brief period of guerrilla warfare that ended in defeat for the whites.



SEMINOLE WARRIOR

Displaying barbaric taste in clothes; he carries a modern rifle

From then until 1816 the Seminoles and their allies were more or less at peace with the Americans. In that year a force of troops under General Andrew Jackson stormed a Spanish fortification on the Appalachicola River in which a number of Indians and negroes had taken refuge, and blew it up, killing some 270 of the 334 men and women who had fled behind its walls for protection. It was this frightful massacre that formally launched the "First Seminole War," and "Blount's Fort," the name of the destroyed works, became the magnetic rallying cry of the inflamed Seminoles, who straightway launched a campaign of retribution against the white plantation owners and government troops.

BY the treaty of 1819, when Spain ceded her rights to Florida to the United States for the sum of 5,000,000 dollars, the Seminoles found themselves under the dominion of the powers they most dreaded. The slave holders, now masters of the newly acquired territory, set up a vigorous clamor for the recovery of their run-away property. The United States, recognizing the Seminoles as a distinct tribe, undertook to negotiate with the Seminole headmen, agreeing to protect the Indians and their property, that is, slaves, herds, and farms as well as hunting territories, from the

A SEMINOLE COOK-HOUSE

The fire is in the center. The long projecting logs are pushed inward as they are consumed

ALL DRESSED UP FOR TRAVELING

A group of Seminoles on the way to a near-by town where they trade. Note the weird costumes

depredations of the whites if the Seminoles would accept certain tracts of land as their reservations.

After debating the proposition, the Indians accepted and retired from the outlying lands into the interior. For a time they were at peace but the slave holders, having won an inch, now proceeded to take a mile. They invaded the Seminole country with bloodhounds and chains, stealing right and left from the Indians. In vain did the Seminoles petition for redress of grievances. In 1828 the Government offered them new lands west of the Mississippi where they might be far away from their persecutors.

AFTER much persuasion, some of the tribal leaders agreed to make a trip of inspection of the proffered territory. They did so and returned, saying it was too cold a country as well as too dry and unhospitable. They decided as a whole not to emigrate. However, by pressure brought to bear upon a few, a treaty or agreement was signed whereby the whole tribe was supposed to be ready to move at a certain date. Naturally those who had no intention of going prepared to resist any efforts to move them. The appointed day arrived without a single Indian being ready to depart.

Troops were sent to enforce the removal order but it was no use. The Indians gathered their families, slaves and portable property and slipped deeper into the Everglades. For years they had been gathering supplies of powder and lead. Their natural resources of food were practically unlimited. Wild game was plentiful and for vegetable foods there were the acorns, palmetto "cabbage" and other native plants. It was war to the hilt.

At this period of the tragic drama, Osceola, or "The Black Drink Hallooer," a young Seminole leader of mixed Scotch and Indian blood, stepped onto the stage. While he was not formally a chief, he was accepted by the Indians as one of their foremost leaders and warriors, an Indian patriot if there ever was one.

The Second Seminole War began in 1835 and for a time, beginning with the frightful massacre of Major Dade's force of 110 men, of whom only two escaped alive, the Seminoles held the upper hand. General after general took charge of the American forces but were unable to accomplish anything tangible.

Osceola was the guiding spirit. The Seminoles looked upon him as their saviour. In the north, a public clamor

SEMINOLE AND WIFE

The "collar" worn by the woman consists of many strings of beads

arose for more energetic action on the part of the soldiers. General Jesup, then in command of the Florida forces, invited Osceola to a conference, under a flag of truce. An armed guard seized the young chieftain and his right-hand man, Wild Cat. This was in October, 1837. In January, 1838, Osceola died, a prisoner at Fort Moultrie, Florida. Wild Cat escaped to his people and, more embittered than ever, carried on the war until 1841, when he was captured by a ruse.

Failing to inveigle the wily chieftain to another treaty under the white flag, General Worth, having captured Wild Cat's little daughter, held her as ransom for her father's appearance. When the Seminole leader heard of the child's capture, then and only then did he consent to come within speaking distance of the American leader. It is related that when the old Seminole warrior came within sight of his baby girl the little one ran to him, holding out in her chubby hands, not flowers or fruit, but musket balls, which she had in some manner obtained from the soldiers.

After listening to General Worth, Wild Cat finally agreed to cease the warfare and emigrate with his people, In 1841 the war was technically over, and band after band of Seminoles, hearing that so eminent a warrior as the Wild Cat had given up, surrendered and made ready to move. By 1843 the last of the Seminoles who had agreed to emigrate had sailed out of Tampa Bay with their few scanty belongings—dusky Acadians bound for a new land of misery.

However, there were a number of Seminoles who steadfastly refused to leave the Everglades. They did, however, agree to maintain a friendly truce with their white neighbors and, keeping faith with their erstwhile enemies, they moved south into the uninhabited marshes of the lower peninsula.

THERE they have lived until this day, a shy, recessive people, holding aloof from all social contact with the whites. Few white men have become intimate friends with them. They have maintained their old customs, living by the products of their swampy plantations, groves of oranges and on the wildlife of forest and stream.

Ethnologically speaking, the Seminoles have always been an interesting people. Perhaps the main reasons for this interest are that they have

clung to their old ways, were not reservation Indians and have consistently refused to accept the Government invitation to go upon reservations set aside for them and be burdened with a lot of red tape "shall and shall nots."

FEW white men or women have ever gone among the Seminoles and won their whole-hearted trust or respect. There have been a few ethnologists and missionaries who have obtained some knowledge of them and their ways, but on the whole the Seminoles have adopted the attitude of "You let me alone and I will let you alone." They have feared to become educated lest they become like white men, because "white man heap lie too much." They point to the sad condition of other tribes who, having rned to read and write in white __n's fashion, have signed away their lands and father's graves. Such things would never do for the Seminoles.

In times past, and even to-day, the Seminoles have lived by their guns and fish poles. They also tilled their small patches of fertile swamp land, raising such crops as sugar cane, sweet potatoes, corn, squashes, melons and fruit. They are skillful hunters and fishers, and while game is not as plentiful as it was at one time, due to the invasion of the white hunters, still they find enough to keep them fairly well supplied. Bear, deer, and alligators have been the largest victims to their modern rifles, while turtles and all manner of succulent fish teem in the waters. Living mostly on the water they have become experts with their canoes, and men, women and children pole the shallow wooden dugouts along the maze of tree-shrouded waterways of the swamps with amazing swiftness and skill.

Living as they do in a warm climate, their habitations and clothing are not elaborate. The houses are mere palmetto thatched, open sheds supported by sturdy logs which serve as catch-alls for miscellaneous collections of game pouches, guns, cast-off garments and cooking vessels. They keep their treasures of hand-made silver ornaments, ceremonial turbans and knick-knacks in chests or trunks.

Both men and women delight in long, flowing, beruffled garments of many-colored calicoes. The women do not follow the dictates of Parisian fashion by wearing short skirts. Their garments are both long and full, while around their necks they wear pounds of beads wrapped in close, heavy bands. The men usually wear a combination shirt and kilt costume, although some wear trousers. Around their home camps they are generally without either shoes or moccasins, but when they journey to the nearest white town for supplies they deck themselves out in shoes, trousers and gay shirts, and sometimes derby hats.

IN THE PINES

A primitive oxen-drawn cart on the way to the Everglades

Many of their old customs still survive, but the last negro slave held by the Seminoles died recently. She was an aged negress who toiled for her red masters long after her brethren had been freed by Lincoln's armies.

Tribal law has always sufficed to keep the unruly in order. Murder and theft are rare among them but, when such things do occur, the criminals are punished in Seminole fashion. Not long ago a Seminole man murdered a boy. Instead of turning the slayer over to white justice, the Indians condemned him to death by shooting. The murderer asked time to settle his personal affairs. This was granted. He went away unattended and was gone 30 days. At the expiration of that period he returned, sat on the edge of the grave prepared for him and was tumbled over with a few well-placed rifle shots.

SOON, however, if one is to believe the newspapers, the picturesque dwellers of the Everglades will be mere nonentities. A young chief, Tony Tommy by name, has appealed to President Coolidge to end the 85-year-old truce. Chief Tony Tommy says he and his people are willing to come under the jurisdiction of the United States.

The clank of dredges draining the Everglades, and the thunder of dynamite blowing out obstructions, are outward signs that sub-division progress and civilization have stamped upon the Everglades.

There will be a few Seminoles, perhaps, who will continue to haunt the depths of the unreclaimed swamp lands —men and women of the old school who do not hold with the teachings of the popular Chief Tony Tommy who is striving to bring his people to a better understanding of their white neighbors. Just a few—but they will in time pass on, leaving a host of Indian place names and a multitude of legends to the new Florida. Then the conquest of the last primeval outpost of our American aborigines will be complete.

A SEMINOLE FAMILY

PREPARING A MEAL

Fish Elevator Aids Spawning

New Mechanism Carries Salmon Safely Over 250-Foot Hydro-Electric Dam to Spawning Grounds

By MANDUS E. BRIDSTON

WITH the advent of power developments, their hydro-electric dams extending hundreds of feet into the air from the surface of the river waters, the way to the salmon spawning beds seemed to be completely blocked. If the salmon could not get up the rivers to spawn, where would next year's pack come from? The problem not only involved the salmon industry with its investments of millions, but affected an important food supply. It seemed more than merely an engineering problem, so the engineers and icthyologists put their heads together and evolved a system of elevating fish to practically any height desired. Previous efforts showed that salmon would not of their own accord climb "ladders" over 50 feet high, so the system now used on the Baker River, in Washington, lifts thousands of fish annually over the 250-foot dam, with a loss of only 5 percent.

The fishway is probably the most elaborate and carefully designed that has ever been built. A concrete rack has been placed across the stream about 1000 feet from the foot of the dam, to prevent the salmon from nosing their way to that impenetrable wall of concrete.

The swift tail-water from the turbines is used to attract the fish to the entrance of the fishway, which is adjacent to the tail-water. When the fish grow weary of struggling in the tail-water, they seek refuge in a comparatively quiet pool provided beside the outlet from the turbines. In this pool the fish are trapped as they enter, and following his biological urge, the salmon ascends from this point through a series of smaller concrete pools, with walls between, over which the fish can easily jump. There are 25 such consecutive two-foot jumps, the fish climbing 50 feet in all.

The most important elements in this "ladder" of concrete pools, are the curved finger-like rods which are placed in each two-foot drop or rung of the ladder, and constitute a guard or trap. These rods do not make a barrier to movement upstream because the salmon invariably jumps over such water falls. But the salmon never leaps in his travel downstream—he merely allows the current to carry him back. This drifting backward is not possible with these traps, and hence the tired fish that would otherwise be carried back is kept in the pool, which is large enough to permit him to rest and recuperate for the still higher climb over the canyon wall.

THE SALMON LADDER

The series of two-foot "steps" are shown here. Note the salmon photographed in the act of jumping

When the salmon reach the last step of the ladder, they are carried 600 feet along a flume to the hoisting tank. Then begins the big ascent, 200 feet up a rail incline in a movable car. When a sufficient number of fish have entered this tank, the doors are closed to prevent the fish jumping out, pulled up a steep incline by motor, and emptied into a trough leading to the lake. The doors, or covers of this tank, serve as baffles to prevent the fish from over-jumping while it is open.

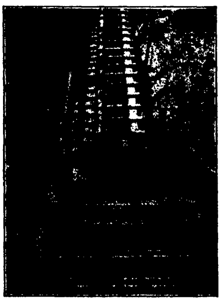
After being emptied into Shannon Lake, they begin swimming toward Baker Lake, which is connected to the former by a short stream. At the entrance to Baker Lake they are caught in a net and carried in large tanks to the government spawning grounds at the head of the lake.

Then begins again the exodus to salt water to renew the six-year cycle in the life history of the salmon. Millions of fingerlings fall over the 250-foot dam. This stupendous dive into the pool below is made with negligible loss of fish, for the engineers have made the dive easy. The two central gates of the dam are opened sufficiently to make this main overpour sought by the fish, while other gates on either side are opened slightly to provide a thin cushion of water on the concrete surface below.

The conflict between the salmon industry and the power interests has been definitely settled, and science has made the pilgrimage to the spawning beds less of a life and death struggle for the fish.

NEAR THE FOOT OF THE DAM

At this point, the salmon are caught in the steel compartment preparatory to hoisting to the top of the dam



ON THE WAY UP

The steel tank, with its load of fish and water, is starting up the inclined track toward the spawning waters above

The Month In Medical Science

A Review and Commentary on Progress in the Medical and Surgical Field

By MORRIS FISHBEIN, M. D.
Editor of the Journal of the American Medical Association *and of* Hygeia

Ultra-Violet Light

THE Council on Physical Therapy of the American Medical Association has made public the results of some investigations to determine whether or not the special forms of window glass which, it has been claimed, will transmit ultra-violet light, actually do so. The sun-parlor or solarium that is glazed with ordinary window glass permits the receipt only of the heat rays of the sun and does not allow the ultra-violet rays to pass. Since it has been shown that the ultra-violet rays are of great importance for proper growth of the human body and also in relationship to resistance against disease, several corporations have begun to manufacture and advertise glazing materials that will permit the passage of the important ultra-violet rays.

The Council on Physical Therapy examined two glasses, Vita-glass and Corning glass, which are real glasses. One substitute, Celo-O-Glass, is composed of wire-mesh screen filled with a sort of celluloid material. Flex-O-Glass is a thin, fairly loosely woven cloth treated with a paraffin-like substance. The materials were examined by placing them in front of the slit of the spectroscope and determining their absorption spectrums. The materials which were translucent and which scattered the rays were tested by a special apparatus devised for the purpose.

A biologic test was also performed on chickens, determining by their gain in weight and by their growth whether or not they were receiving adequate amounts of ultra-violet light through the various glasses.

Corning glass and Vita-glass were found to be as transparent to visible rays as is window glass. The Celo-O-Glass and Flex-O-Glass are not transparent, but were found to be useful in solariums and for the raising of animals or in other instances in which a transparent glass is not essential. Both of the latter substances are less expensive than ordinary window glass, but the Flex-O-Glass does not withstand the severe weather as well as does the Celo-O-Glass. The waxy coating has a tendency to soften in hot sunshine, and dust will adhere to the softened surface. All of the materials mentioned were found to have the property of passing the ultra-violet or health-giving rays of sunlight. The Vita-glass and Celo-O-Glass transmitted a sufficient amount of ultra-violet rays to control the development of rickets. The Flex-O-Glass did not transmit these rays so well, but even this substance was much better than ordinary window glass.

Loose Jointed or Double Jointed

ALMOST everyone is familiar with the contortionist of the vaudeville stage or the circus, as well as with persons in his own acquaintance-ship who may have the mobility of the joints commonly referred to as "double jointedness." It is realized that the joints of thin people can be moved farther than can the corresponding joints of the fat. There are many thin persons, particularly women, whose joints in the knee, elbow and fingers can be bent in either direction to extraordinary degrees. Dr. J. Albert Key, of St. Louis, has described some instances of unusual mobility of the joints occurring in various members of a single family.

DOUBLE JOINTEDNESS
This condition is a sex-linked hereditary characteristic, as explained in the text

In the case concerned, the father had hypermobility, but the condition was not present in his parents or in any of his nine brothers or in his sister. It was, however, transmitted by the father to all four of his sons but not to any of his five daughters. Although the father's feet were normal, except for unusual mobility of the joints, all of the male children were born with deformities of the feet of the clubfoot type, whereas none of the girl children had such deformities. Apparently the condition is transmitted according to what is known as a sex-linked hereditary characteristic, transmitted as dominant in the male line. The joints are weak because of some developmental defect which makes the ligaments loose, although they may appear to be as strong as they should be normally.

Boric-Acid Poisoning

THE tragic deaths of six babies from drinking concentrated solutions of boric-acid solutions instead of distilled water because of error in the preparation of the solutions has called attention to the potentialities of boric acid as a poison. Compared with carbolic acid, lysol or bichloride of mercury, it is relatively nonpoisonous. There are, however, records of deaths even of grown persons who have received considerable quantities of solutions of boric acid. In some of the cases that are reported in medical literature, one to three grams or one fourth of an ounce of boric acid has produced serious symptoms, and from one half ounce to an ounce of the drug has been fatal to an adult.

In the cases reported the babies weighed about seven pounds and must have received at least a pint of saturated solutions of boric acid in 24 hours, or approximately one fourth of an ounce of boric acid. This substance is used so frequently as a household article that its power for harm has been overlooked. However, it has been forbidden to use boric acid as a food preservative in the United States, France, Germany, Holland, Italy and Spain.

The Health of the Eskimos

THE MacMillan Arctic expedition of 1926, visiting the Eskimos of northern Labrador and of Greenland, was accompanied by a physician who used his time in making studies of the Eskimos' diets to determine some im-

portant facts. These Eskimos live for the most part on diets consisting largely of meat and fish. The meats concerned are those of the whale, walrus, seal, caribou, musk ox, artic hare, polar bear, and fox, as well as those of geese, duck and gulls. The fish are varied. This food is usually eaten raw.

The physician, Dr. William A. Thomas, reports that, contrary to general opinion, the Eskimos eat relatively little fat or blubber, using these portions for oil in lighting their homes, in melting ice and snow for drinking, and, to a very little extent, for cooking food.

The Eskimos prefer red meat, eating the flesh and particularly the liver of animal or fish. However, when the supply of food is inadequate, they will eat any part of the animal, including the entrails. Dr. Thomas reports the unusual fact that the polar bear's liver is for some reason poisonous and that even starving dogs will leave it untouched.

Since meat is commonly forbidden to persons with kidney disease, he made a special examination to find out whether or not these Eskimos suffered unusually with these disturbances. He found, however, no unusual prevalence of blood-vessel or kidney diseases, or even of high blood pressure. These Eskimos lead a life of some physical activity, involving violence, accidents, starvation and freezing. Due to varying food supplies they frequently alternate between overeating and starvation.

Dr. Thomas did not find any scurvy or rickets among these Eskimos – conditions that are known to be due to absence of certain vitamins from the diet. The children are nursed for four, and not infrequently for six years, until their teeth are strong enough to permit them to eat meat. It is well known that the tissues of the animals and the fish, including particularly the liver, are rich in important vitamins.

In Labrador, the meat is cooked instead of being eaten raw. The natives eat much dried and canned food, and there is much scurvy and rickets, even though the Labrador mothers also nurse their babies for long periods. Since the mothers themselves eat only sophisticated diets, they do not have in their milk the necessary vitamins for their nursing offsprings.

It is interesting to know where the animals themselves secure their vitamins in their diets. The birds eat fish; the polar bear eats seal; seal eats fish; walrus eats clams; the caribou, hare and musk-ox eat moss, grasses and such sparse vegetation as may be found; the smaller fish subsist largely on marine vegetation, and thus, Dr. Thomas points out, the vital question apparently is answered by the well-known scriptural saying that "All flesh is grass."

A Collapsed Lung

SOMETIMES during a serious surgical operation, or after a serious attack of disease, the lung on one side, or on both, will suddenly collapse so that it will no longer act as a bellows capable of filling with air and emptying itself. The symptom is a serious one, since complete collapse of the lung does not permit the entrance of air and the patient dies promptly. If only one side is collapsed, as is usually the case, the person may develop severe symptoms, which, however, tend gradually to disappear, so that after two or three weeks the lung suddenly is reinflated and the person makes a complete recovery. The X-ray pictures accompanying this item indicate the appearance of the chest when normal and after there has been a complete collapse of the lung on one side.

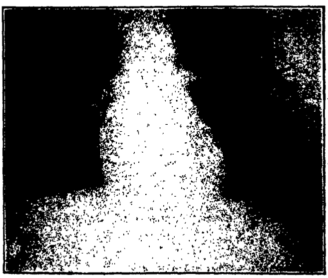
Dr. L. R. Sante, of St. Louis, recently discovered a simple procedure to be used during surgical operations when this symptom occurs. He found that merely rolling the patient over on the side that was not collapsed and causing him to cough would cause the collapsed lung to reinflate itself promptly with air and resume its functions.

With the usual thought of prevention rather than cure in mind, he suggests that, after all operations, patients be rolled first on one side and then on the other and that they have their positions changed every few hours during the first few days after the operation in order to avoid this possible complication. The exact cause of the condition is not known, but it apparently has something to do with a temporary injury to the nerves that control the actions of the breathing apparatus.

Changes in Children's Clothing

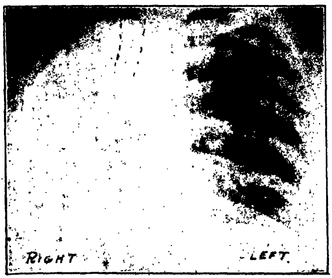
A WELL-KNOWN manufacturer of children's clothing in New York City has made available an experience of the concern of great interest from both an anthropologic and medical point of view. The firm has been in this business for 38 years. It is now recorded that complaints are being received that the neck measures of dresses for babies one, two and three years of age were not large enough, and it has been necessary to increase these measurements by one inch in each case.

Whether or not this observation is related to a change in body form in the American type or whether it has to do with an increasing tendency to disturbances of the thyroid gland is, of course, not determined, but the facts themselves are interesting.



X-RAY OF NORMAL CHEST

Both of the lungs are in their normal positions and are functioning as they should. Collapse has not as yet taken place



ONE LUNG COLLAPSED

Four hours after an operatic collapsed. Rolling the patien

Successful Inventors—VIII

They Seek More Than Money, Says One of Them

By MILTON WRIGHT

"THE inventors who read the SCIENTIFIC AMERICAN are interested in the outstanding inventors of the country," we said to C. Francis Jenkins, whose first conspicuous invention was motion pictures—called the Phantoscope in those days—and whose latest invention—radio vision—promises to be just as epoch-making.

"These inventors are seeking knowledge and inspiration," we went on. "They are interested, not so much in being told what to invent or how to invent, but in finding out how they can reap the benefits of their inventions. In other words, how to make money out of their ideas."

"I do not agree with you," said Mr. Jenkins. "I know of no *pioneer* inventor who is actuated primarily by a desire for money. Take my case, for example. I am a professional inventor. For years I have been earning my living by inventing. I am still inventing, but whether I make a lot of money out of my invention, or whether I don't, does not interest me greatly. I invent because inventing is what I like to do. I think the same thing is true of all inventors of *pioneer* inventions.

"HERE is another thing that I believe is true of all great inventions. There is no great invention that I know of which has been produced by men trained and experienced in the line which naturally would be expected to produce such an invention. The cotton gin was invented by a cabinet maker; the steam engine was developed by a miner; the telephone by a teacher of the deaf, and so on. I was a stenographer when I invented motion pictures."

"But how did you get started at being a professional inventor?"

"Frankly, I don't know what really started me, that is, what gave me the idea for my first invention. I was raised on a farm and I probably was born with a talent for machinery. As a boy on the farm out in Indiana I was supposed to keep all the farm machinery going. It was while on the farm that I learned stenography. I obtained a text book and used to sit on a plow-beam studying it. This knowledge eventually brought me to Washington. In 1890 I became secretary and stenographer to Sumner I. Kimball, organizer of the Life Saving Service. In my spare time, nights and holidays—and being in the government service we used to have lots of holidays—I worked on my idea for motion-picture apparatus. I had to make everything myself—the camera, the strip of film, the developing apparatus, the printing machine for making a positive film from a negative, apparatus to perforate the strips of film so they could be pulled off the reel and accurately moved along through the machine, and so on. There is the motion picture projector I finally produced."

As he spoke, Mr. Jenkins pointed to a crude wooden model of a motion-picture machine on a nearby table.

C. FRANCIS JENKINS

Mr. Jenkins was a pioneer in motion-picture work and is now engaged in the development of radio vision apparatus

"In all its essentials," said he, "that is the same as the motion-picture projectors in use in every theater today."

"How long did it take you to produce that?"

"It took a couple of years before I got projection. In January, 1892, I made the first successful projection with an oil lamp. In the next year I used a carbon arc. About January, 1894, I obtained my first patent."

"Did you sell your patent immediately?"

"No. There was nobody to sell it to. Like all inventions, this one needed capital for development purposes, and a friend, James P. Freeman, advanced me some money—about 50 dollars, I think it was. Freeman became ill after a little while, needed the money, and I began to pay him back in installments. Early in 1894 the device began to attract attention in Washington, for I gave exhibitions, projecting life-size pictures, and on July 6th of that year, the *Photographic Times* printed an interesting description of it.

"In 1895 I made an agreement with Thomas Armat for promotion purposes. Mr. Armat was to assume all the expenses and to get a half interest in the patent. We made three machines, copies of my 1893-4 machine, and took them to Atlanta, Georgia, where the Cotton States Exposition was being held. An account of test exhibitions given with these machines before they were shipped south was reported in the Baltimore *Sun*, of October 2, 1895.

"At the exhibition in Atlanta we got hold of the best 'ballyhoo' man we could, to try to get people to come in to see this wonderful new invention, for 25 cents. They would not come because the barker could not make them understand what it was. Do you know, you cannot describe motion pictures to people who have not seen them? People have to see motion pictures to know what they are like. Finally we solved the problem by inviting people to come in and sit down and rest. Then when we got enough of them in the hall we would put out the lights and start showing motion pictures. When we finished we would suggest that if they cared to they could leave 25 cents at the box office for the show they had seen. Many of them paid. We had a few real feature pictures. Some of them were as much as 100 feet long!

"IN January, 1896, Armat exhibited the machine at the Postal Telegraph Building in New York in an effort to interest some men with money. At this time Edison was getting interested in the subject. He had invented a peep-hole machine. I went to Philadelphia and demonstrated my Phantoscope at the Franklin Institute. By this time Armat and Edison had got together and Armat protested my claim that I was the inventor of the Phantoscope. Nevertheless, the Franklin Institute

committee reported favorably on my claim and also reported adversely on Armat's protest, and I was awarded the Elliott Cresson gold medal in 1898 for the invention of the Phantoscope. Thirteen years later the Franklin Institute awarded me the John Scott medal for improvements on the same inventioı

"Did you make enough money out of moving pictures as you went along to keep you going?" we asked Mr. Jenkins.

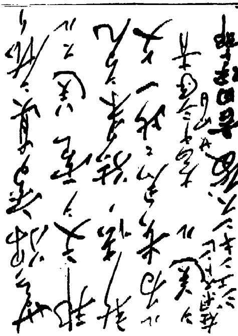
"No, indeed," he replied. "All this time I was working as a secretary and stenographer, but soon after the fight with Edison was over I went to Mr. Kimball and resigned. I determined to be a professional inventor. I was like the inebriate who bought a saloon so that it would either kill him or cure him.

"I HAVE never given up motion pictures entirely. Some 15 years ago I made a 'movie' machine, calling it the Graphoscope, a machine designed especially for use in schools. All of the film was placed below the source of light so that a booth would not be needed, and there would be no danger of fire. Many cities and several states endorsed it."

"But how did you put the machine on the market?" we asked. "Did you just sell your patent or lease it on a royalty basis?"

"I went to New York with the school machine," he said. "The promoters to whom I talked laughed at me. They ridiculed the motion-picture business generally, because motion pictures were considered rather disreputable in those days. My idea was to make the 'movies' respectable, to utilize them as a means of education.

"The men with money were not convinced, so I came back to Washington determined to prove that I was right. I organized a little company, manufactured machines and induced the principal of every high school in the city of Washington to install one. In a radius of 50 miles of Washington we sold ten times as many machines as all our competitors combined. After a year I went back to New York with the evidence. Within a week they gave me 60,000 dollars, and more later.



IDEOGRAPHS BY RADIO

This reproduction of a message in Japanese was sent and received by the Jenkins system of radio picture-transmission

"Most of my motion-picture work since that time has been along specialized lines. For example, I have invented a camera which takes photographs on a standard motion-picture film at the rate of 3200 exposures a second. This produces wonderful slow 'movies' which are extremely valuable in studying movements of many kinds."

"But what is your most profitable invention?"

"The spirally wound, waxed-paper container for liquids. It was designed originally to take the place of ordinary milk bottles. The milk bottle, it was estimated, costs five cents and makes ten trips. Then, too, milk bottles are more or less unsanitary. We made a good many thousands of these containers to take the place of milk bottles, but we found that we could not make much money competing with the glass bottles which only cost about a half c

"We decided to find other uses for the container, and it was not long before it was being used for oysters, butter, pot cheese, ice cream and a wide range of products. We doubled the price of the containers."

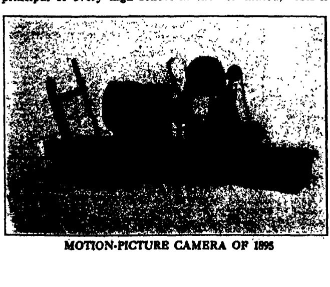
"Did you manufacture the containers yourself?"

"YES, we formed a corporation to put the new article on the market. There had to be a lot of machinery invented, for nobody had ever before made such a paraffined tube out of manila paper. The thing was pretty successful, and I sold out to a New York group after having obtained about 80 or 90 patents in that particular field. This was about five years after I had first invented the container."

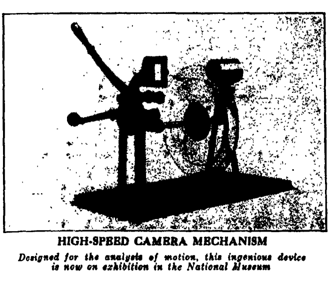
"What do you consider your greatest invention?"

"Like many inventors I consider that the greatest is the one that I am now working on—visual radio. With this invention the wireless will carry motion pictures into the home. I already have about 35 patents on the invention and about 70 are pending. A number of things had to be devised. Motion pictures can be made only on flat surfaces. We had to develop mechanism to work on flats. We had to send a ray of light in an oscillating straight line, and so I invented a prismatic ring which is a solid glass prism which changes the angle between its faces. We would be having radio 'movies' in the homes now if I had not been interrupted by the Government last August to develop the radio weather-map.

"It is the radio weather-map upon



MOTION-PICTURE CAMERA OF 1895



HIGH-SPEED CAMERA MECHANISM

Designed for the analysis of motion, this ingenious device is now on exhibition in the National Museum

RADIO PICTURES IN THE HOME

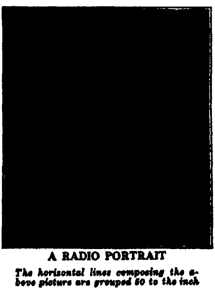
Mr. Jenkins predicts that it will be only a matter of months when this form of entertainment will be available

WEATHER MAP RECEIVING APPARATUS

The stylus records the received impulses on the paper attached to the cylinder, which is driven by the motor

which I have been working for several months. Professor Charles F. Marvin, head of the Weather Bureau, Map-Division Chief Calvert, Captain McLean, head of Communications in the Navy and Commander Hooper, head of radio in the Navy, asked me if it was feasible to transmit weather maps by radio to ships at sea. I said it was, and started work to devise a way of doing it. The Weather Bureau prepares the daily weather-maps, and we receive them at 11 o'clock every morning. They are then put on our machine in the Navy Building which is connected to the Arlington radio towers by wire. The maps are broadcast as radio impulses or signals in a special form.

"Aboard ship there is, attached to a radio set, a small machine on which we have affixed a map blank. As the impulses are received by radio from the broadcasting antennae at Arlington, they are written in contrasting colors on the map blank. The apparatus is now working with complete success. In the tornado which swept the Florida coast, the *U.S.S. Kittery*, which was receiving the maps, was effectively warned in advance and able to change its course and skirt around the edge of the storm. In a short time I hope to be able to get back to visual radio and devote my time and energy exclusively to its development."



A RADIO PORTRAIT

The horizontal lines composing the above picture are grouped 60 to the inch

"How soon do you think it will be before we will have motion pictures by radio?"

"I believe it is now only a matter of months before radio 'movies' will be available to the public."

"Will we be able to use the radio receiving sets we have now for receiving motion pictures?"

"I do not know yet. It all depends on whether or not we can use the present broadcast band. But this you can be sure of; we will be receiving motion pictures by radio in the home at no distant date."

"Do not great inventions nowadays come usually from the laboratories of great corporations by research engineers?"

"NO great pioneer invention has been made in the laboratory of a great corporation; and by pioneer inventions I mean new mechanisms which started new industries. It is always some outsider who makes the great innovation.

"The corporation laboratories exist to make improvements, perfect inventions upon which the industry is founded, simplify methods of manufacture or devise new items of manufacture. Their purpose is not to produce inventions upon which to found new industries.

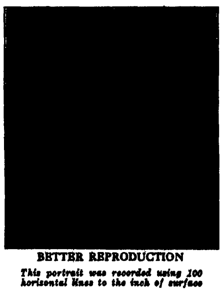
"Here is another peculiar thing I have noticed. Great inventions in a new field are not usually taken up by those who would seem to be the most likely to be interested. For example, Dr. Bell told me that the telephone was turned down by the Western Union Telegraph Company. It seems as though it takes men outside of a particular industry to have vision enough to see the possibilities which lie within the industry."

"Wouldn't you say, Mr. Jenkins, that inventors are born and not made?"

"Yes, in a sense, but a lot of work and training can do much to develop a man's native ability. Probably a lot of playing around with tools and machinery is necessary before a man is able to work out his ideas to a point where they will amount to invention. I cannot remember the time when I was not interested in making wheels go 'round; then I went to Mexico and had a lot to do with mining machinery. Altogether I had a pretty good background before I started seriously the job of inventing."

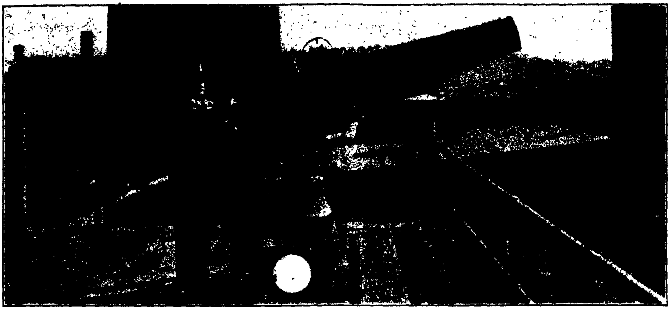
"You have said that inventors are not interested primarily in profits. What would you say interests them more? What compensates them more than money?"

"Your real inventor is like your real poet or composer or sculptor. He takes an idea and he molds it and shapes it into tangible form. Out of nothing he makes something that is useful, something mankind has never known before, something that means one more step upward in the climb up the ladder of civilization. He brings into being a new industry. Money comes to him incidentally, if his invention is worth while, but the inventor's truest reward is knowing the joy of creation. I can think of no greater satisfaction."



BETTER REPRODUCTION

This portrait was recorded using 100 horizontal lines to the inch of surface



Photographs courtesy General Electric Company

THE AERIAL-SIGN PROJECTOR

At the rear of the cannon-like apparatus is located the 18-inch searchlight that furnishes the illumination for projecting pictures, signs and the like through a series of lenses to natural clouds or smoke-screens created for this purpose

THE SEARCHLIGHT "GUN" IN ACTION

trained on the side of a ... sign will be in constant
...re arranged so that the ... from the "gun," thus eliminating

Sky-Painting with "Light Gun"

To be used for advertising and display purposes, a new long-range projector for photographs, drawings, signs and so forth has been developed by W. D'Arcy Ryan, director of the illuminating engineering laboratory of the General Electric Company. Essentially, the device, in its present laboratory form, consists of a powerful searchlight mounted behind a series of lenses and a slide holder. The two latter components are encased in a housing which, in shape, resembles a cannon. According to the inventor, the "gun" illustrated is only a small one and he confidently predicts that soon similar projectors of a larger size will be developed. These, it is said, will be capable of projecting images for a distance of five miles. The apparatus is designed for casting these images on a cloud bank, so that they will be visible for miles around. A lens arrangement makes focusing unnecessary, so the image can be shifted quickly from one point to another. When it is desired to make use of the wide-spread advertising ability of the device, and no clouds are available, it is planned to create artificial clouds by exploding smoke-bombs at proper intervals. The images from the projector will then be thrown on this opaque mass. A revolving screen in front of the muzzle of the projector can be used to produce color-changing effects. This glorified "magic lantern" can also, as illustrated above, be used for projecting its message on the sides of buildings and the like. It is thus apparent that the "light gun" will be very flexible for advertising purposes.

THE RIM OF METEOR CRATER, ARIZONA, FROM WITHIN

The strata on the left were tilted up nearly vertical when the great projectile struck them. Those at the right were left horizontal but were raised bodily 100 feet; this is the "arch." Between them there is a fault line concealed by debris. Compare this illustration with the map of Meteor Crater, published in last month's installment

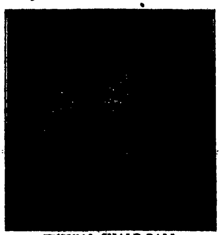
The Most Fascinating Spot on Earth—II

The Immense Comet Buried Beneath Meteor Crater Doubtless Contains Tons of Precious Metals

By D. MOREAU BARRINGER, Jr.

AN intensive study of the physical features of Meteor Crater was next undertaken, with the hope of finding some clue as to the direction of approach of the meteorite—for it was now obvious that it had not fallen vertically after all. Largely by accident, my father observed one day that by firing a rifle into mud he could make an excellent replica of the Crater, and, moreover, that the rifle need not be fired vertically downward, but might be held even less than 45 degrees from the horizontal. Naturally one would suppose that a shot at such an angle would make an elongated hole. But it will not. The hole will be just as round as though the shot had come straight down, although the projectile will lodge under one edge of the hole instead of in the center. A charge of shot fired from a shotgun at close range will produce the same effect.

A STUDY of the interior walls of the Crater finally revealed an important fact. As I have mentioned before, the rocks exposed in the walls dip radially away from the hole. But this dip is quite variable. (See map of the Crater, published in last month's issue.) If a line be drawn through the center of the Crater, about ten degrees west of north and east of south, the dips will be seen to be curiously symmetrical with respect to that line. Starting at the point where the northern end of the line strikes the rim of the Crater, and proceeding in either direction around the Crater toward the south, the dips increase from five degrees up to about 60 degrees, which angle they attain at two points, each about 120 degrees around the hole from the starting point. Then, on either side of the Crater, there are blocks of the rim, one about 300 feet long and the other about 500 feet long, where the rocks dip approximately 90 degrees. Between these two blocks, and completing the circle on the south, is a 2700-foot section in which the dip is again as low as five degrees, that is, the rocks in the cliffs are lying practically horizontal.



TYPICAL SHALE BALL

About natural size. It is now entirely converted into nickel-iron shale

This last section is in the form of a wide, flat arch, its center being about south 10 degrees east of the center of the Crater, with its ends abutting the sections of vertical strata on either side. The rocks in the center of this arch are raised about a hundred feet above normal.

NOW let us look at these dips with the idea in mind of a projectile plowing downward and southward through the rock. The simile of a plow is not a bad one. When a plow just scrapes the surface, the ground is not much disturbed or uplifted. The deeper it goes, the more it raises and bends back the ground above and beside it. Similarly, supposing the projectile to have entered the ground near the northern edge of the present hole, we find the rocks there relatively little disturbed or uplifted. The farther south we get, and the deeper the projectile gets, the more it has bent back the rocks on either side of it. Eventually its lifting force is spent. It slips under the southern edge of the hole, raising and doming the rocks above it, but lacks the energy to throw them aside, as it has thrown aside the rocks farther north.

The observed symmetry of the dips so well fits this theory of the direction of approach that further corroboration seems almost unnecessary. But there is plenty of it to be found. The north rim is lower than the south. This is

due in part to the lower dip of its strata, but chiefly to the fact that a far smaller volume of excavated material has been deposited on the north. The amount of this ejecta increases progressively toward the south, on both sides, until the greatest volume is found on the southern rim, where the arched and uplifted strata are. The largest individual blocks of ejected rock are found in two groups, one on the east and one on the west side of the Crater. This effect can be duplicated with the rifle and mud experiment.

Only on the southern rim is there found any trace of the lowest ejected rock—the brownish red and lowest member of the Coconino sandstone. This is quite in order, for the projectile did not reach the depth at which this rock lay until it was close to the present southern edge of the hole. Various other indications of this symmetry along a diameter of the hole running north ten degrees west could be cited.

Chiefly for lack of funds, this theory of the direction of approach of the meteorite was not acted upon until 1920. In that year, a prominent mining company took a lease on the property for the purpose of exploring it. They sunk a churn-drill hole on the southern rim, as near as possible to the center of the great southern arch.

THE sinking of this hole was attended by many difficulties, but eventually it reached a depth of 1376 feet, where the drill became permanently stuck. But valuable information was nevertheless obtained from the work. Starting at a depth of some 1200 feet, small fragments of oxidized meteoric material were encountered, admixed with the shattered sandstone. As the hole got deeper, this material increased rapidly in quantity, until near the bottom of the hole it was comprising some 75 percent of the ground. In all respects it answered the description of the oxidized meteoric iron found at or near the surface. Now it would have been manifestly impossible for any small amount of this material to drive itself to this depth into the rocks beneath the cliffs. To enable any meteoric material to get to such a position, the whole mass must have plowed a way for it.

In other words, it is almost certain that the drill is now in contact with some part of the main meteorite, or rather the main cluster of meteorites.

Unfortunately, this mining company had greatly exceeded the estimated cost of drilling the hole, and was unwilling to go to the further very large expense of sinking a shaft to explore the meteorite. They therefore abandoned their lease. There the matter rests today, but it is shortly to be reopened.

TWO OF THE METEORITES

Pieces of ordinary small Meteor Crater meteorites, several pounds in weight

Having thus briefly described the history of the enterprise, it may be of interest to give a description of the character of the meteorite itself, insofar as it can be deduced from the evidence at hand, which is not scanty.

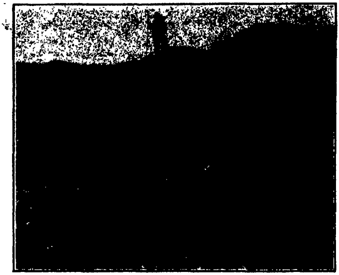
Of the pieces of meteoric material found at or near the surface the best known, of course, are the chunks of solid nickel-iron, known as the Canyon Diablo meteorites. They are to be found in every large museum. They are irregularly shaped blocks of metallic nickel-iron, with the surface, as is characteristic of many iron meteorites, looking as though thumb-marks had been made all over it when it was soft. When cut they reveal a bright, silvery surface, which will rust only very slowly or not at all. If this surface is etched with acid, the so-called Widmanstätten figures of crystallization are plainly seen. The composition of this unoxidizable iron is roughly as follows: iron, 92 percent; nickel, 6 percent; carbon (both crystalline and graphitic) phosphorus, et cetera, 2 percent; cobalt, copper, et cetera, traces; platinum, iridium, palladium, and other metals of the platinum group, about four tenths of an ounce per ton. The pieces so far found, numbering many hundreds, range in weight from less than an ounce to about 1400 pounds.

During the earliest explorations conducted by my father and his associates, they discovered large quantities of what they termed "iron shale." This occurred in pieces from less than an ounce to 300 pounds in weight, and its distribution was about the same as that of the metallic pieces. It is composed of iron oxides, and, allowing for the addition of some 30 percent of oxygen and water, its composition is identical with that of the metallic iron. It has a shaly or laminated structure, which gave rise to the name.

Very frequently this iron shale, instead of occurring as flat pieces, was found in the form of round, oval, or pear-shaped bodies, laminated concentrically, and ranging in diameter from an inch or so to three feet or more.

HURLED BY A GIANT FORCE

One of the very large, half-buried fragments of limestone thrown out on the western slope of the Crater, by the meteor



THE INNER RIM OF THE CRATER

The ou the lim

These were termed "shale balls." Nearly every piece of the iron shale not in the form of these balls shows evidence, by its curved structure, of being simply a fragment of a shale-ball that has been broken up by the forces of oxidation and erosion. We may safely assume, therefore, that all the oxidized material we now find was once in the form of shale-balls.

When these shale-balls were found imbedded in the flour-like dust from the crushed sandstone, which forms a part of the rim and which is almost water-proof, they frequently contained a center or core of metallic iron. In most cases this core oxidized rapidly on exposure to the air, because it contained up to two-tenths of one percent of chlorine. But occasionally there would be found, in the interior of one of these shale-balls, one or more pieces of iron which contained no chlorine, and which was therefore unoxidizable, just as the common Canyon Diablo meteorites are unoxidizable. Only recently one of the workmen told me that he once found a shale-ball weighing over a hundred pounds, which yielded, when broken up, eleven small iron cores. I have found three in a small shale-ball weighing less than three pounds.

SEVERAL of the unoxidized cores of shale-balls have been sawed across, and then allowed to rust. In two cases, at least, there has appeared on this surface an area which refused even to tarnish, but kept its silvery appearance as bright as the day it was cut. And in each case the outline of that area resembled the outline of an iron meteorite—that is, it showed the shallow concavities which mark all the metallic pieces found at the Crater.

These unoxidizable nucleii are identical in all respects with the typical Canyon Diablo meteorites, a fact which has led my father to the belief that all the Canyon Diablo meteorites were once similar nucleii in much larger shale-balls. This theory is further borne out by another point, namely, that of their shape. This, as I have said before, is of the greatest irregularity. Their surfaces, however, all tend to exhibit the so-called "thumb-marks" or shallow depressions, which are well shown in the upper illustration on page 145. On the other hand, the shale-balls invariably have a rounded shape. This immediately suggests the shape of cobblestones in a creek-bed. The only two ways in which they could have attained this shape are by being abraded from without, or by being fused and "dripped," as molten lead is dripped to form shot. We know that they could not have been molten, for all the pieces of iron and even some of the shale show the Widmanstätten crystallization figures, which completely disappear when the iron is heated to 1500 degrees, Fahrenheit. Therefore they must have been bumped and rubbed into their rounded shape—and this could only have been done by other pieces of iron, floating near them in space.

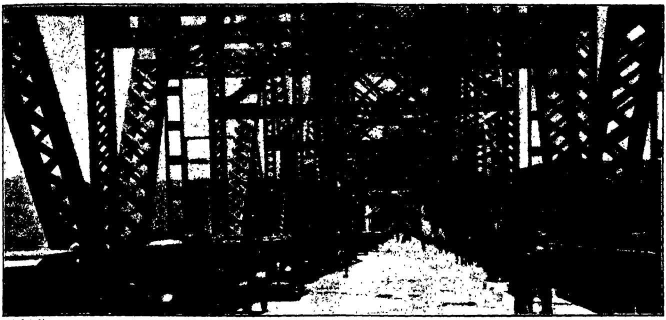
SLIGHTLY TILTED STRATA

Part of the interior wall of the Crater, on northwest side. At this place the strata are slightly tilted, as indicated on the map published with the first installment of the article

Imagine a dense cloud of pieces of iron, flying through the interplanetary space within our solar system. Their own gravitational force, slight though it is, holds them together, but the far-off pull of passing planets, and their changing position relative to the sun, cause slight but constant readjustments in the swarm. At every contact of two of the pieces, an infinitesimal corner is knocked off or flattened. Given many millions or even billions of years for this process to continue, the members of the swarm will all have assumed a rounded shape. The tiny particles rubbed off, perhaps of hardly more than molecular dimensions, travel with the swarm, until the cluster approaches relatively close to the sun, when they are pushed out in the direction away from the sun by the pressure of its light.

The majority of astronomers now believe that comets are just such swarms of rounded iron meteorites, traveling closely together, and sending out a tail of finely divided material when the pressure of the sun's light becomes sufficiently great. Both the comet and the tail, of course, are luminous only by reflected light from the sun, for both are probably at a temperature very close to absolute zero (−458 degrees, Fahrenheit). I think there can be little doubt that the mass which, in striking the earth, produced Meteor Crater, was a typical comet, although possibly a small and relatively dense one.

¶ *In his third and last installment Mr. Barringer will show how the size and composition of the buried comet can be deduced from the available evidence.*



P. & A. Photo

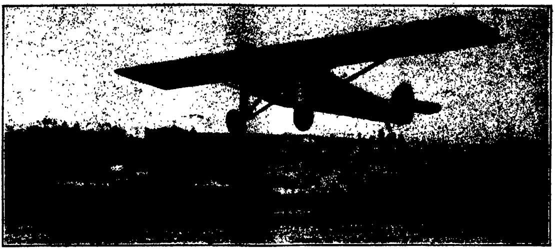
THE COMPLETED CARQUINEZ BRIDGE

ile toll bridge, Contra opened to traffic. The *bridge, which took fou million dollars, provides*

LIFTING A SPAN BY COUNTERWEIGHTS

Something New in Bridge Building

The phenomenal growth of automobile traffic was one of the main incentives to the building of the handsome Carquinez toll bridge, north of San Francisco. It is claimed that this is the largest automobile highway bridge in existence. It has been under construction for four years at a total cost of over eight million dollars. As will be seen from the illustrations, it is a cantilever structure of the standard American type, made up of box and latticed members, eyebars, and with wide panels. Although the bridge presents no striking novelties in its design, a distinctly new method was adopted in raising the suspended span into place. Hitherto it has been customary to float the span into position below the bridge on the deck of large pontoons and lift it into place by cables operated by motors situated on the cantilever ends. In this bridge, the lifting was done by means of heavy counterweights, whose cables passed over sheaves carried at the ends of the cantilevers.



LINDBERGH'S RYAN MONOPLANE

a Wright Whirlwind air-cooled e

Air-Cooled Engines For Aircraft

An Historical Survey of the Design and Development of These Engines in America

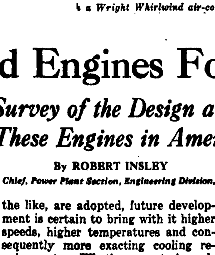
By ROBERT INSLEY

Assistant Chief, Power Plant Section, Engineering Division, Air Corps

THE 20-year war between the supporters of air-cooled and water-cooled aviation engines is rapidly dying out with the desertion of most of the water-cooling adherents to the ranks of the enemy. The air-cooled engine is very definitely in the ascendency and apparently is shortly to become the predominant aircraft power plant. This is not at all surprising. Air is the obvious cooling medium for an aircraft engine. The interposition of the more tractable intermediate cooling medium between the cylinders and the air has been in the nature of a makeshift, serving our purpose until we could learn how to direct air cooling.

IT does not follow that the water-cooled engine must now be considered obsolete. The suitability of the air-cooled engine for all types of aircraft and all conditions of service has by no means been proved. For all conditions of service likely to be encountered at present, or in the near future, it appears now that the air-cooled engine can demonstrate its superiority. But our aviation engine development in the past has consisted simply of design refinement and utilization of better materials. There has been very little change in the fundamental operation of the engines. Whether that plan of development is continued, or some drastic fundamental changes, resulting from our present experiments with superchargers, two-cycle engines, fuel injection, and the like, are adopted, future development is certain to bring with it higher speeds, higher temperatures and consequently more exacting cooling requirements. Whether or not air cooling can keep abreast of such development remains to be seen.

The first successful aviation engines were water-cooled. The remarkable five-cylinder radial engine designed in 1901 by Charles M. Manly for Langley's experiments and the Wright Brothers' four-cylinder engine with which they accomplished their first flight in 1903 were both water-cooled. The air-cooled engines, however, were close behind. It was with a 24½ horsepower Anzani air-cooled engine that Bleriot first crossed the English Channel in 1909.



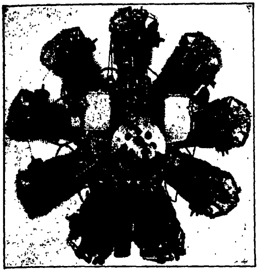
VERTICAL-FIN CYLINDER

In this type the head is integral with the cylinder, but it was abandoned in favor of a type using a head screwed and shrunk onto the barrel

The first Curtiss engines were air-cooled. There was no dearth of air-cooled engines nor lack of interest in the type, but the water-cooled engine, because of its relatively simple design problems and because of the enormous assistance contributed by the parallel development of the water-cooled motor-car engine, advanced much more rapidly.

THE war provided impetus for the air-cooled engine. The rotary engines, the Gnome, LeRhone and Clerget, as the lightest examples of air-cooled power plants, were built in enormous quantities—to be unceremoniously discarded after they had served their emergency. The rotary engines, while they performed valuable service during the war, contributed little to the advancement of the air-cooled engine. Their inherent faults—windage loss, gyroscopic effect, difficulty of control—resulted in their early demise. We can therefore safely regard the progress of the fixed air-cooled engine, both radial and line types, as representative of the development of the air-cooled engine in general. The pioneers in this work were the Renault, Anzani and Curtiss Companies.

The Renault 70 and 80-horsepower



WRIGHT TYPE R-1

Left: Several test runs of this engine showed its weak points, and it was completely redesigned, to appear in rebuilt and improved form under the type designation R-2

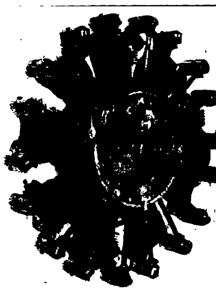
WRIGHT TYPE P-1

Rig use of ... pull rods across ... of the cylinders. are plainly shown reproduced photo

engines, while exceptionally sturdy and dependable power plants, could boast of little in the way of cylinder performance in comparison with the performance of contemporary water-cooled engines. Their performance was about what should be expected of their cast-iron, side-valve cylinders and blower cooling. An early Royal Aircraft Establishment development was the R.A.E. 4A, a 12-cylinder, vee, 140-horsepower air-cooled engine with cast-iron, side-valve cylinders. The bore of the 4A engine was 100 millimeters and the stroke 140 millimeters. The cylinder performance, 85 pounds per square inch brake mean effective pressure, although an improvement over that of the Renault cylinders, was still considerably lower than the performance of the best water-cooled engines of the time, although the engine was extremely dependable.

THE R.A.E. 4D engine, which was produced early in 1917, differed from the 4A engine principally in cylinder design. The 4D cylinder consisted of head and barrel of cast aluminum, into which an open-end steel liner was shrunk. The steel valve-seats were cast into the head. In this cylinder the side valves were replaced by overhead valves and the upper half of the combustion chamber was of spherical form. In performance the 4D cylinder showed a marked superiority over the 4A, producing a brake mean effective pressure of approximately 108 pounds per square inch. Although the 4D engine was never put into production, the success of the cylinder indicated the possibilities of improvement of air-cooled cylinder performance by such design investigations. The R.A.E. 4A engine was the last of the air-cooled vee engines produced in any quantities, and with that engine the vee type was entirely abandoned in air-cooled engine development until its revival by the United States Army Air Service in 1923 in the form of the air-cooled Liberty.

The cylinder studies by the Royal Aircraft Establishment continued with the design and test of a large number of air-cooled cylinders of various types and materials in sizes up to eight-inch bore and ten-inch stroke. The 4E cylinder was a modification of the 4D, with larger valves and with four instead of two hold-down bolts. Both the 4D and 4E cylinders, however, suffered from poor thermal contact between the steel liner and the aluminum barrel. This difficulty led to the development of cylinders with all-steel barrels, both open and closed ends, with various types of heads.



WRIGHT TYPE J-5

This sturdy engine, known as the Whirlwind, is the type used in the famous Ryan transatlantic monoplane illustrated at the top of the opposite page

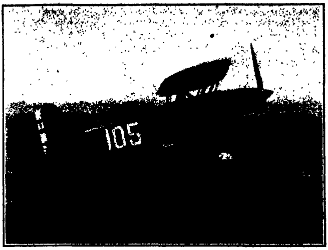
The A.B.C. cylinders for the Wasp and Dragonfly engines were constructed with a one piece, closed-end steel barrel, a flat head, valve seats machined in the steel head, two exhaust and one intake valve, and separate cast-iron and aluminum valve-ports attached by studs to the cylinder head. As might be expected, these cylinders had very poor head cooling, the valve life was very short and the fuel consumption necessary for most satisfactory service was excessive. To correct these troubles, the R.A.E. 21T cylinder and the 21TD, differing from the 21T in details only, were designed.

The 21TD cylinder consisted of an aluminum head cast on an open-end steel barrel. The head was spherical and single intake and exhaust valves were used. The valve seats were cast into the aluminum head. Test results showed these cylinders to be much more successful than the earlier type, but difficulty was experienced in obtaining satisfactory bonding between the head and barrel. A modification of this type, in which the cast-aluminum head was bolted rather than cast to the open-end steel liner was considered unsatisfactory because of insufficient thermal contact at the joint.

A later British development, the cylinder type to which American air-cooled engine progress is most directly indebted, was the open-end steel barrel with cast-aluminum head screwed and shrunk on the barrel. In this cylinder, the valve seats were cast into the head. The spherical combustion chamber with single intake and exhaust valves was very similar to that of the R.A.E. 21TD cylinder. This type of cylinder was used first on the Siddeley radial but is now in general use in modified form in England and the United States, on all types of air-cooled engines. The British development of the air-cooled cylinder continued, of course, beyond this point, but the steps mentioned formed in general the foundation on

INVERTED AIR-COOLED LIBERTY

For purposes of easier installation and repair, this engine was designed for operation in the inverted position shown



CURTISS "HAWK" WITH LIBERTY ENGINE

This side view of the plane and engine shows the exhaust pipes and the location of the covers over the valve mechanism

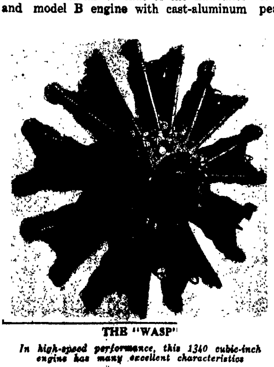
which the larger part of American air-cooled engine progress has been built.

During the period of the war and immediately afterward there was in the United States very little air-cooled engine development worthy of the name. However, in 1916, Charles L. Lawrance produced the Lawrance A-3, a 28-horsepower, two-cylinder, air-cooled engine used to some extent in "penguin" training machines. His model B, also produced in 1916, was a three-cylinder, radial type with cast-aluminum cylinder head and barrel, with steel liner pressed into the barrel. His cylinder construction was very similar to the R.A.E. 4D cylinder.

IN 1920, after attempting unsuccessfully to interest several other aircraft-engine manufacturers in air-cooled engine construction, the Engineering Division of the United States Army Air Service undertook a definite program of air-cooled development by the announcement of a competition for the design and construction of an air-cooled, radial engine for pursuit airplanes. Seven designs were submitted and finally a contract was entered into with Mr. Lawrance for the construction of four nine-cylinder air-cooled engines of 160 horsepower, to be known as the Lawrance R-1.

The Lawrance R-1 was delivered to the Engineering Division and successfully completed a 50-hour test in 1921, the first American air-cooled engine to successfully pass such a test. Fifty of these engines, enlarged in capacity, but identical in other details (called the Lawrance J-1), were purchased during the same year by the United States Navy for training purposes. The Lawrance R-1 engine was the starting point for the development of the first American production of air-cooled aviation engines. It has been developed over a period of five years and is now represented by the highly successful Wright Whirlwind type J-5 engine. This engine was used by Captain Charles A. Lindbergh in his Ryan monoplane in which he made his now historic non-stop flight from New York to Paris. The engine is described in detail in the section devoted to aviation notes in this issue.

The Lawrance R-1 engine cylinder was similar to that of the Lawrance model B engine with cast-aluminum head and barrel, pressed-in cylinder liner, relatively flat head, two valves and cast-in valve seats. This general cylinder construction was continued with only detail changes until, in the J-4 model, the upper end of the cylinder liner was threaded and screwed into the aluminum casting. The cylinder construction was again changed in the J-5 model and a spherical-head cylinder, developed by the Engineering Division of the United States Army Air Service, was substituted for the J-4 type.



THE "WASP"

In high-speed performance, this 1340 cubic-inch engine has many excellent characteristics

In 1922 the Wright Aeronautical Corporation delivered the Wright R-1 engine, fitted with the Engineering Division type J cylinder. The first 50-hour test of this engine was terminated after 47 hours through failure of the master connecting rod. A duplicate of this rod was modified slightly, the compression ratio increased to 5.4 to 1 and the 50-hour test repeated. The second test was terminated after 43 hours through piston and crankshaft failure. Following this test, the engine was rather generally re-designed and rebuilt for the third 50-hour test, which was terminated in preliminary calibration runs through piston failure.

ON the basis of these tests, a contract was written with the Curtiss Aeroplane and Motor Company for three R-2 engines to be similar in general construction to the rebuilt R-1. This engine incorporated a built-in rotary induction system, type M cylinder and special crankpin lubrication system. This engine recently passed its 50-hour test and is now in service test status. The type designation of the engine has been changed to Curtiss R-1454. This engine represents the first American application of the rotary-induction system which has since been incorporated in all of the larger air-cooled engines.

Coincident with the competition for air-cooled radial engines, the Army Air Corps initiated a series of tests of air-cooled cylinders similar to the tests conducted at the Royal Aircraft Establishment. The cylinder investigation at the Engineering Division started with what now seem grotesque

examples of air-cooled cylinders. The early tests were conducted largely with cylinders composed of aluminum heads and barrels cast on steel cylinder-liners. Bronze valve-seats cast into the heads were used in nearly all of the early tests. The types of construction tested included axial fins, circumferential fins, bolted-on heads, integrally-cast heads, roof heads, flat heads and other minor modifications of design. All of these types for one reason or another were unsatisfactory and the later development has been concentrated on the cast-aluminum head screwed and shrunk onto the forged steel barrel.

The first three of the cylinders with screwed-on heads were designed to investigate the relative value of two, three and four valves and of roof-head, flat-head and spherical-head cylinders. The H cylinder was a four-valve roof-head cylinder, the I a three-valve, flat-head cylinder and the J a two-valve, spherical-head cylinder. The results of tests showed the spherical head to be superior to either of the other types from the point of view of cooling, and two valves to be entirely adequate for cylinders of this size, (five and five eighths by six and a half inches). The development was continued with the J cylinder.

IT will be impossible in this article to discuss in detail the development of the air-cooled cylinder by the Engineering Division, but the principal results may be briefly stated as follows:

a. First development of high mean effective pressure air-cooled cylinders. "High mean effective pressure" in this instance refers to brake mean effective pressures in excess of 130 pounds per square inch, maintained over long periods of operation.

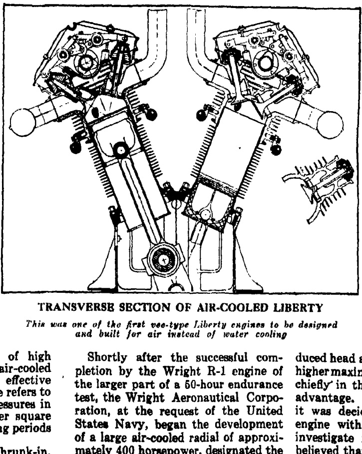
b. Development of the shrunk-in, aluminum-bronze valve seats. While this may appear to be unimportant, no more than a glance at the troubles that have attended the use of cast-in, rolled-in and peened-in seats and the general adoption of the shrunk-in aluminum-bronze seats in cast-aluminum heads is required to prove its value.

c. The development of the enclosed valve gear for air-cooled aviation engines. This type is represented in the K and M cylinders. The advantages are complete oil-bath lubrication of the valve gear, with consequent elimination of wear, partial compensation for valve clearance, retention of push rods when a valve spring fails, and protection of valve gear from the effects of exposure (particularly desirable in operation in the vicinity of salt water).

d. The development of a foundry practice and the commercial application of special alloys for cylinder-head castings.

e. The investigation of valve cooling and valve materials and the development of properly proportioned salt-cooled and standard valves for air-cooled engines.

f. The vindication of the large, two-valve, air-cooled cylinder. The Engineering Division two-valve X cylinder with 188 cubic-inch displacement develops 133 pounds per square inch brake mean effective pressure at 1800 revolutions per minute; approximately 166 pounds indicated mean effective pressure.



TRANSVERSE SECTION OF AIR-COOLED LIBERTY

This was one of the first vee-type Liberty engines to be designed and built for air instead of water cooling

Shortly after the successful completion by the Wright R-1 engine of the larger part of a 50-hour endurance test, the Wright Aeronautical Corporation, at the request of the United States Navy, began the development of a large air-cooled radial of approximately 400 horsepower, designated the Wright P-1 engine. This engine employed the screwed and shrunk aluminum-head cylinder with, however, an unusual type of valve mechanism in the form of a push-and-pull rod across the top of the cylinder. The engine has been developed through several models, but its general acceptance as a service type has been delayed by a series of unfortunate incidents encountered during its experimental development.

The latest entry into the air-cooled radial field, representing a very creditable bit of engine design, is the 9-cylinder, 1340 cubic-inch Pratt-Whitney Wasp. In many particulars, this engine is superior to any air-cooled radial previously in existence. Its actual test-development-to-production status has been accomplished in a remarkably short time. Its performance characteristics, particularly in the matter of smoothness and high-speed performance, are excellent. It has a bore and stroke of five and three-fourths inches, and a piston displacement of 1340 cubic inches. It is rated at 400 horsepower at a normal speed of 1900 revolutions per minute and weighs, bare, approximately 650 pounds. It employs the familiar screwed and shrunk cast-aluminum head cylinder similar to the type M developed by the Engineering Division for the R-1454 engine, but with the lower halves of the rocker box integral with the cylinder-head casting. The cylinder has a spherical head, single intake and exhaust valves and shrunk-in valve seats. The crankcase is of forged duralumin and carries a built-in rotary-induction system at the rear.

NO more than mention has yet been made of the revival by the Engineering Division of the air-cooled, vee engine last seen in the R.A.E. 4A engine in England. Air-cooled engine studies by the Engineering Division led to the belief that a high-duty, air-cooled, vee engine could be designed to operate satisfactorily and would have considerable advantage, in the larger sizes at least, over the radial type. The advantages considered at the time were reduced head area, increased smoothness, higher maximum crankshaft speeds and, chiefly in the larger sizes, installation advantage. In order to test the theory, it was decided to rebuild a Liberty engine with air-cooled cylinders and investigate its performance. It was believed that if the air-cooled Liberty, with 45 degree angle between cylinder banks, could be made to cool satisfactorily, there should be little difficulty in cooling any air-cooled, vee engine.

The first experimental engine was built in the upright type and cooled very satisfactorily through three torque-stand 50-hour tests. For airplane installation advantages, the subsequent air-cooled Liberty engines have been inverted. They have given an excellent account of themselves in flight service and, in direct comparisons with the most advanced representatives of the air-cooled, radial types in similar installations, have certainly showed (*Continued on page 182*)

All photographs by Martin Johnson, courtesy American Museum of Natural History

AFTER A SUCCESSFUL SHOT

r. and Mrs. Martin Johnson, with a group of their native helpers and one of the animals which they shot

A MODERN DIANA IN AFRICA

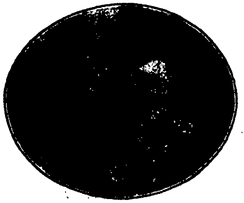
Mrs. Johns

ON THE MARCH IN BRITISH EAST AFRICA

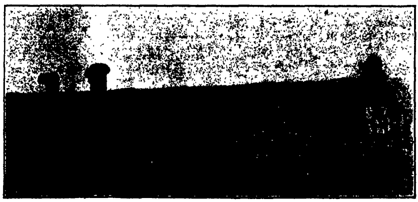
The members of the Martin Johnson expedition with their cameras and other equipment packed on native bearers and "African pack horses"—camels

A NATIVE MOTHER

The natives posed for the cameras for consideration of 25 cents a day



A LEOPARD IN CAPTIVITY



WILD ELEPHANTS CHARGE THE HUNTRESS

The Camera as an Aid to the Naturalist

The animal films and "stills" taken by Mr. Martin Johnson have never been surpassed. It would hardly be fair not to mention Mrs. Martin Johnson in the same paragraph, for she handles a gun as fearlessly, and a camera almost as skillfully, as her husband. They have just returned from a three and one half year sojourn in Africa. They brought back 200,000 feet of motion-picture film and 7,000 "still" photographs as a result of their great photographic hunt, for they believe in using the lens rather than the rifle. However, they also believe in preparedness and do not fare forth without guns. Most of their records were made on the shores of a lake on the Abyssinian border which the Johnsons named "Paradise Lake." Large numbers of wild animals from the surrounding country come there for water and forage. Mr. Johnson, in an interview on his arrival, said that there were many lions, elephants and rhinoceri, particularly elephants, which showed great fondness for the sweet potatoes in the Johnson garden. He also spoke of lions which had never heard a rifle shot and were

AT A DESERT OASIS

Several groups of camels gathered at a watering place, possibly to lay in a supply of water for a coming drought

WATER IN THE DESERT

Surrounded by vegetation peculiar to the locality, this water hole, or spring, is a godsend to man and beast

FILMING TYPICAL AFRICAN NATIVES

Operating an Akeley type of motion-picture camera, Mr. Johnson secured many feet of film that are now invaluable for ethnological records

GIRAFFES SEEKING WATER

Because of the timidity of the beasts, Mr. Johnson used a long-focus lens for this picture

A JUNGLE PET

Mrs. Johnson and one of her pets, together with a native and buffalo head

AFRICAN FISH

Mrs. Johnson seems to handle a fish line as well as she does a rifle

VICTIM OF RIFLE AND CAMERA

In a frivolous moment, Mrs. Johnson poses with one of the dead rhinoceri

fearless of men. Mr. Johnson said he easily made pictures of them with his still and motion-picture cameras, while Mrs. Johnson stood near by with a rifle, ready to shoot if necessary. The rifle, he said, was used rarely, and the pictures showed the animals serene and unsuspicious. The original negatives made by the expedition will be presented to the American Museum of Natural History. Their next expedition, which they expect to start soon, will be into the Congo to make pictures of the gorilla, the habits of which are still little known to scientists, and of the okapi, a curious animal which has rarely been photographed. The films shown at the American Museum of Natural History were wonderful and the lecture had to be repeated immediately to accommodate those waiting in the exhibition galleries. What proved to be most interesting was the spirit of friendliness, almost politeness, which the animals showed to each other at the drinking places. How Martin Johnson entered motion-picture work is worth recording. Jack London went to the South Seas in 1908 aboard the *Snark* and Martin Johnson officiated as photographer and cook. When the vessel touched at one of the South Sea Islands, he saw for the first time a motion-picture camera, operated by two Frenchmen. They grew tired of their job and put their apparatus in Johnson's hands. Since that time his films have had no superiors in wild-life cinematography.

From the Scrap-book of Science—

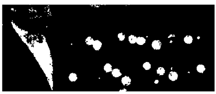
Wide World

NEW ALLOYS

Left: Dr. T. D. Kelly, English research worker, has discovered two new iron-copper combinations which show high resistance to attack by acids. A third alloy called "solium" is said to resemble platinum, although it is lighter

BIRD BANDS

Below: Laurence M. Huey, Curator, Natural History Museum of San Diego, California, has been studying bird migration habits by means of numbered metal bands placed on the legs of birds. Later the birds are trapped, recorded and subsequently released



P and A

ATOMIC ARRANGEMENT IN SALT

If a microscope could come anywhere near revealing the atoms—which it does not, although X rays do—the sodium and chloride atoms in table salt would look something like this model

Underwood and Underwood

NEW TEST BEATS ALIBIS

Whether a man—or a woman—has been drinking or not can be proved with this new apparatus

Harris and Ewing

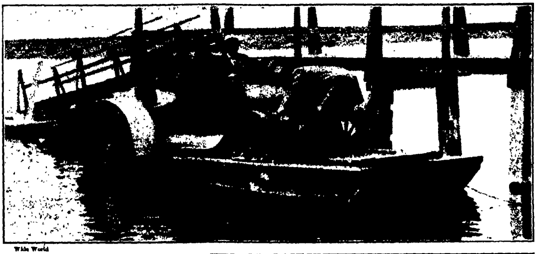
HOW MUCH WILL A WOODSCREW HOLD?

A lot more than many of us think. The United States Bureau of Standards has just been finding out, by means of tests on 10,000 screws

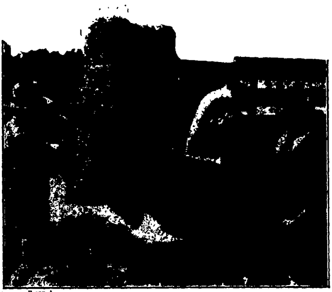
Camera Shots of Scientific Events

WHAT NEXT?

Here is a "flivver" converted into a "yacht." The rear tires have been replaced with paddles, and "Lizzie" navigates the waters near Wintrop, Massachusetts. Mr. C. Wesley Smith is the captain of the ship as well as the owner. Has anyone tried converting a Ford into an airplane? Considering the odd things that have been done with them, we should not be surprised to hear of this



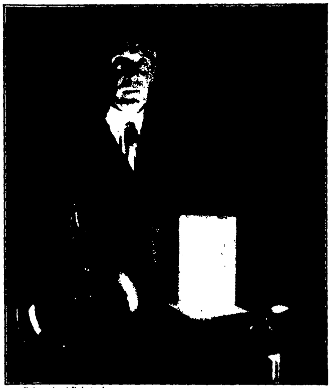
Wide World



P and A

X RAYING FOR SUSPECTED BOOZE

Out in Los Angeles, the District Attorney is well up with the times. He has equipped his enforcement men with regular X-ray apparatus with which to examine various boxes suspected of harboring "hooch." The photographer who posed this picture was obviously not an X-ray technician



Underwood and Underwood

PHOTOGRAPH TAKEN BY INVISIBLE RAYS

Prof. R. W. Wood, of Johns Hopkins University, photographed in fluorescent light from a chemical called eosin

Wide World

NEW COLOR-MATCHING MACHINE

More accurate than the human eye is the machine developed by Professors Hardy and Cunningham of Boston "Tech"

Herbert Photos

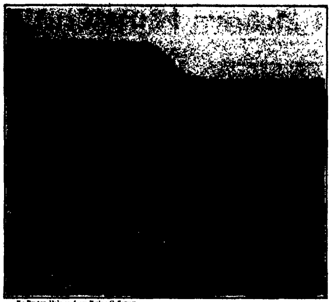
HUGE ELECTRIC LOCOMOTIVE

Now in use in Switzerland, it weighs 288,350 pounds, is 65 feet long, and has six electric motors of 4500 total horsepower

By Burton Holmes, from Ewing Galloway

PREPARING BAMBOO OYSTER-STICKS

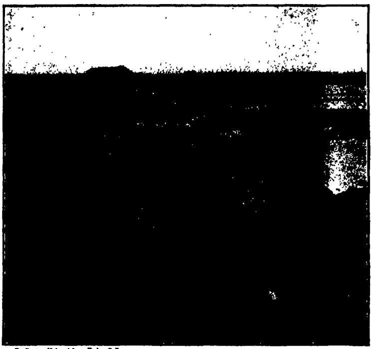
The sticks upon which oysters are to be grown are split from large pieces, weighted at one end, and sunk in the water



By Burton Holmes, from Ewing Galloway

WHERE THE OYSTERS ARE COLLECTED

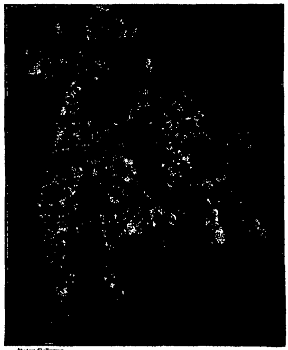
At this station in Formosa, the half shells are left on the ends of the sticks to provide more surface for the next crop



By Burton Holmes, from Ewing Galloway

OYSTER BED AT AMPING, FORMOSA

ow tide, shows part of the arrangem
ts for the cultivation of large oyster c



Ewing Galloway

OYSTERS ON BIRCH BRANCH

Oysters Now Grown On Trees

For many years, the natives of the island of Formosa have been cultivating oysters in a crude way, but it remained for the United States Bureau of Fisheries to apply modern science to the problem and provide over-crowded oysters with places where they could live and mature in comfort and with a low mortality rate. One of the prime reasons for the decrease of the oyster industry in this country has been the fact that oyster beds become so crowded that thousands of the bivalves die before they attain maturity. According to William Firth Wells, of the Conservation Commission of the State of New York, the solution of the problem resolves to one of providing clean places of attachment for the drifting oyster larvae. Coupled with this must be a method of supplying a dependable source of the larvae, and it is in this work that Mr. Wells has been engaged for the past few years. It must be understood that the first ten days to two weeks of the young oyster's life are spent in a free, floating condition, where it is exposed to many dangers. After this time, the oyster attaches itself to some stationary, clean object, and grows there for the rest of its life. If there is not ample room, the oysters crowd each other and a large majority of them find it impossible to survive. At Milford, Connecticut, birch branches are being placed in oyster beds to serve as permanent homes for oysters, and thus far the experiment is successful.

Household Inventions

Devices Illustrated on This Page Make Housework Easier

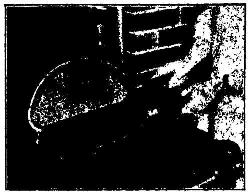
CONDUCTED BY ALBERT A. HOPKINS

ELECTRIC BAKER

This device bakes doughnuts, small cakes and breads, six at a time. Made at the table, they are ready to be eaten within five minutes

REVERSIBLE PAN

When open, this frying pan will cook two different foods. When closed, it can be used for baking on top of the stove

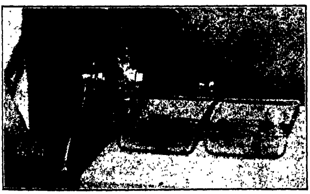


BAKING KETTLE

Aside from the usual uses, this aluminum kettle, with rack and thermometer, may be converted to a serviceable top-of-stove oven

CABINET TABLE

In the illustration at the right is shown a new type of kitchen cabinet. In this new model is incorporated a sliding table top, separate from the usual porcelain work table. This top is especially designed for breakfast use, eliminating the necessity of setting the table. Everything required for service is in its regular place in the cabinet, handy to those at the table. This model seats three comfortably



PIT EXTRACTOR

The removal of seeds and stems from the juice and pulp of fruits, as well as the pulverizing of dry materials is accomplished with the device shown

CAKE PAN

This pan is designed for use on top of the stove. A mica window allows observation of cake while baking. A hole is provided for inserting a straw

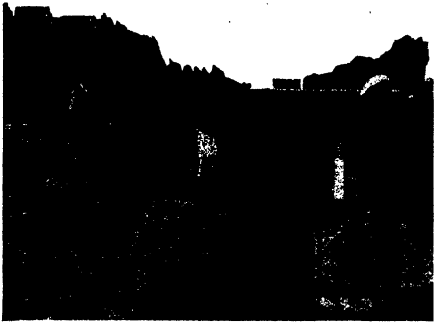
PAN HOLDER

The wire arrangement shown can be used for lifting and tilting hot pans, and for a variety of purposes

REPLACEABLE BLADES

The edge of the blade of the bread knife shown is replaceable. A thumbscrew holds the blade in position

Inventions in the Field of Sport

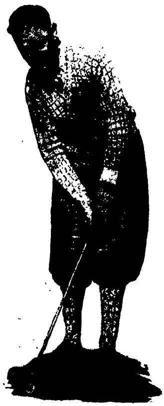


GOLF BALL CLEANER

No longer will it be necessary for the golfer to get his hands covered with sand and water as he cleans his ball at the tee, providing the new ball cleaner shown in the foreground in the illustration at the left is used. With this, the ball is inserted in a slot in a vertical member, the latter is drawn up and down, and the ball revolves between two brushes. It is said that by this action the ball is thoroughly cleaned, yet the enamel finish is not harmed in the least. Carefully cleaned balls are easier to find after a long drive

SEAT FOR THE BABY

The folding seat shown above enables the child to see what is going on, at the same time keeping him out of mischief



ON THE LINKS

The adjustable club in use looks just like any other "iron"

ADJUSTABLE GOLF CLUB

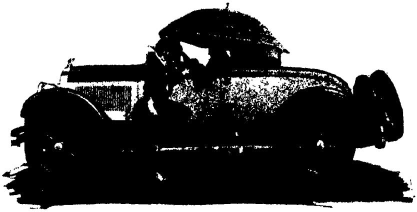
To eliminate the necessity of buying and carrying a whole bagful of clubs in order to play the game of golf correctly, a professional golfer has invented the improved adjustable "iron" shown above and below in detail, and at the left in use. With this club, the angle between the head and the shaft can be quickly varied, according to the "lie" to be played, yet the head cannot change its position while in use. Thus, the same club can be used as a putter or a niblick, or as any of the intermediate clubs, a twist of the shaft changing the head angle and locking the head

MINNOW BUCKET

This cover converts any ordinary pail into a minnow bucket. The cover is held in place by several metal spring clamps

SPORT UMBRELLA

Large umbrellas made of heavy twill, and with strong frames, are now on the market, designed to be used for various purposes such as those shown at the right and below. An umbrella of this type may be securely fastened to a sport roadster to serve as an emergency top, or can be quickly removed and used as a beach umbrella. A window in the umbrella contributes toward safety. It is said that when on a car, the umbrella is not disturbed, even at high speeds. In a test conducted at a speed greater than 70 miles per hour, the umbrella stayed firmly in place, showing no tendency toward buckling or other damage



SAFETY BATHING SUIT

A series of air-inflated tubes fastened under the material of the bathing suit shown at the right makes it impossible for the wearer to sink. These tubes are composed of a heavy rubber fabric and are of such shape and size that they do not make the suit unduly bulky. Wearing a bathing suit of this type, a novice with no knowledge of swimming need not be encumbered with awkward water-wings or similar aids to the embryo swim

COMFORT IN THE WATER

Not one of the young ladies in the above illustration can swim, yet they are as at home in the water as if they were born to it. The reason for the ease with which they float around reading newspapers in a nonchalant manner is the bathing suit shown at the left. Wearing suits of this type, with air-filled tubes inserted, it is impossible for them to sink below the surface

LIFE-SAVING BELT

A comparatively inconspicuous belt, which can be worn without discomfort at all times when there is danger of a sudden immersion in water, is shown above and at the left and right. This belt contains an inflatable rubber portion and is equipped in the front with a receptacle containing a glass bulb filled with a compressed gas. When the belt is to be used for a life belt, a screw in the container is turned, breaking the glass bulb. The released gas immediately fills the rubber compartment, providing sufficient buoyancy

The Scientific American Digest

A Review of the Newest Developments in Science, Industry and Engineering

CONDUCTED BY ALBERT G. INGALLS

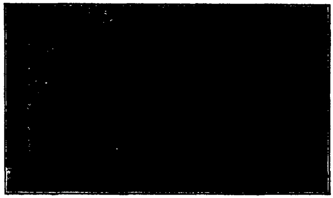
The End of the Old-Fashioned Sidewalk Bridge

PRACTICALLY all large cities have ordinances requiring a sidewalk bridge on each building operation. In the past, very little attention has been given to providing a sidewalk-protection bridge which would combine the two vital essentials, namely, safety and good appearance. There is no time during normal business periods when there are not a great many of these structures standing on or near the city streets.

With the idea that a considerable saving could be effected if contractors used some standard steel supporting-structure to meet varying conditions found on different operations, a modern steel sidewalk-protection bridge has been developed. This can be erected and dismantled more rapidly than the old type of wooden structure. Also, compared with the old-fashioned type, it does not interfere with the orderly movement of pedestrian traffic.

The new steel supporting-structure is constructed of standard units which can be erected in such a manner that the width of the passageway may be varied to suit conditions. The distance between columns may be varied in a longitudinal direction to provide for obstructions, driveways, et cetera, and can be erected with equal facility on level or sloping sidewalks. This condition is met by the clamp arrangements which enable the various members to be fabricated to suit actual requirements on the ground, without necessitating drilling of bolt holes.

The columns are made of four-inch steel pipe and the supporting beams are eight-inch, 25½-pounds-per-foot steel I-beams. The connecting pieces are of one and one-half inch steel pipe. On the steel I-beams, a wooden nailing strip is bolted to provide for attaching the wooden beams.



ample light to the side

A completed sidewalk bridge. Trim and neat, it takes the place of the unsightly, gloomy wooden structures that have been an undesirable feature of building operations until lately

California Redwoods to be Tried in East

FIRST experiments in planting California redwood trees in the east for commercial purposes will be made shortly, when a small shipment of redwood seedlings will be set out in Natural Bridge and other national forests of Virginia, H. M. Sears, supervisor of Natural Bridge forest, has announced.

The redwood will be planted on Back Run, near Natural Bridge, in the local forest. It will be given a try-out on experimental plantations of the other Virginia preserves. The work is being done in cooperation with the state forester at Charlottesville.—*Science Service.*

The New Science and the Old Religion

IT is a long time since we have seen a book that brings together so many things of the kind that, we think, will interest SCIENTIFIC AMERICAN readers, as does Dr. Thornwell Jacobs' "The New Science and the Old Religion." Dr. Jacobs is president and founder of Oglethorpe University, Atlanta, Georgia. He is a Southerner and has obviously kept in mind while writing his book the recent epidemic of anti-evolutionism in the South. The work is not, however, a polemic. Evolution, organic and inorganic, takes in nearly everything in the universe, and so does "The New Science and the Old Religion." It begins with the stars and ends with written history, touching in its broad sweep the sciences of astronomy, geology and paleontology, biology, anthropology and many others.

How the structure is clamped together. It may be dismantled, moved and set up elsewhere, undamaged

The culvert "gopher" at work, driven by a gasoline engine. The jack in the foreground keeps the rig up against the work as it advances. Traffic keeps right on

As the title implies, Dr. Jacobs has not avoided religion. Far from it. His main thesis is that there is religion in science, science in religion, and between the two, nothing incompatible. The book should also be read by the intelligent fundamentalist, whom it would not offend.

The composition and press work, it is interesting to note, were done entirely by the students of Oglethorpe University at the Oglethorpe University Press, and the work is creditable. The book is unusually well illustrated, largely by important illustrations judiciously chosen from the works of such well-known scientists as Millikan, the physicist; Hale and Lowell, the astronomers; Chamberlin, the cosmologist; Scott and Osborn, the paleontologists; Slosson, the chemist, and Haeckel, the biologist. The price is $3.75 postpaid.

Texan Invents Culvert "Gopher"

In the past the only method for installing culverts has been to cut out half of the pavement, place one half a length of culvert and then backfill, allowing traffic to use the other half of the pavement in the meantime. In like manner the other half of the culvert was placed. It was, of course, then necessary to let traffic travel over the backfill for some time to insure its compactness before the concrete could be replaced. In order to allow continuation of traffic, only half the roadway could be poured at one time, as it was necessary for the concrete to stand several days before it had sufficient strength to carry traffic. This method was unsatisfactory.

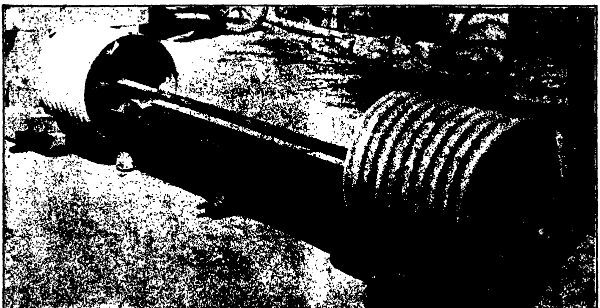
For some time F. E. Wilson, County Engineer of El Paso County, El Paso, Texas, had been figuring on a method of placing these culverts under roads without cutting the pavement. Not long ago the matter was taken up with C. A. Campbell, a well-drilling contractor of El Paso, who, with available second-hand equipment, worked out the plan and rig used for the illustrated installation. The plan was a success. The pipe was installed and the pavement was not cut.

The plan was to use a motor with the drive shaft extended to the length of pipe to be installed, with cutting blades attached to one end. This shaft was held in place in the center of the pipe by blocking at four different places. A trench was then dug outside of and at right angles to the pavement, sufficiently wide, deep and long to place the engine and the entire length of pipe, all assembled on a skid track in the bottom of this trench. By means of blocking and a small three-ton jack, the pipe was then pushed up against the embankment to be cut through. As the cutting took place ahead of the pipe, blocking and jacking of the pipe into place continued until the entire pipe was put through, pressure being put on the cutting blades at all times. To take care of the dirt coming back through the pipe, another shaft, driven from the main shaft, was run through the pipe, with a nine-inch cotton-seed conveyor riding in a smooth sixteen-gage sheet-metal form. This delivered the dirt to the rear end of the pipe where it was easily shoveled out of the way.

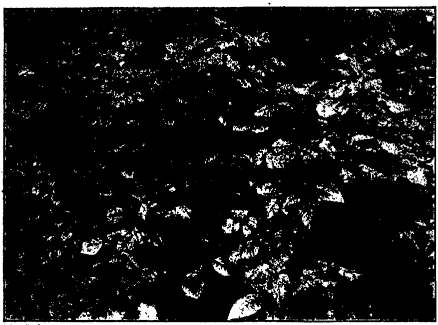
Through! The end of the pipe was not even bent or damaged in the least. Traffic was not delayed, the road was not taken up, and gasoline did the hardest part of the work

Experience has already indicated that a few changes should be made in the rig. First, the main shaft should not be driven direct with the drive shaft of the motor but should be geared down. Second, the shaft should carry a second set of cutting projections heavier than the blades and of a smaller cutting diameter, placed in front of these blades, for roughing out the opening. Third, a flywheel should be used on the shaft. Other improvements than these undoubtedly will be made, but these three were most forcibly brought to attention during the first trial.

On this one installation, setting up the rig and placing the pipe (which was an armco iron pipe, 24 inches in diameter by 26 feet long) took five days and probably cost as much as the old method,



How the culvert "gopher" was assembled. At the right are the cutting blades, driven by a shaft. Below this shaft is a spiral conveyor for removing the excavated earth as the "bit" of the device advances



Science Service

Poison ivy and its west-coast relative, poison oak, are very much alike in general appearance. They grow either as climbing vines or as erect, slender-stemmed shrubs from underground rootstocks, and are distinguished by their glossy, green, three-part leaves, unlike those of any other common plant

but it is believed that after a few installations, pipe of this size and length can

Poison Ivy Conquered by Simple Chemicals

"POISON IVY, the bane of the vacationist's existence, is with us again. Remedies by the hundreds are recommended by doctors, by druggists, by old-fashioned housewives. Some of them work; some of them just serve to keep the patient in as cheerful a frame of mind as possible until the afflicted place gets well by itself," says Dr. Frank Thone, of *Science Service*. "The handling of ivy poisoning, and of its kindred ailments, oak and sumac poisoning, is still in a more or less chaotic condition.

"Scientific order, however, is being brought out of it by the efforts of botanists, chemists and physicians," continues Dr. Thone, "and now there are a few standard remedies, and what is even better, standard preventives, that anybody can have his corner druggist mix up in few minutes. There is nothing patent or proprietary about them; they are all old familiar chemicals, and they do not cost much.

"The best remedy is axiomatically one that destroys the cause of the ailment, and it is for this reason that Dr. James F. Couch, of the United States Department of Agriculture, expert on poisonous plants, recommends the use of a solution of permanganate of potash to stop the itching, blistering irritation that follows contact with poison ivy, poison oak or poison sumac. Five percent of the compound in water is all the prescription your druggist will need. Bathe the afflicted skin freely with this solution, swabbing it on with a bit of cotton or soft cloth, and the poison will be oxidized and destroyed. This treatment leaves a brown stain on the skin, which can easily be removed in any one of a number of ways. A 1 percent solution of oxalic acid, Dr. Couch says, is the quickest means.

"But oxalic acid is a poison, so that if you are afraid of children getting hold of it, you may use instead a 1 percent solution of sodium bisulphite, or even just plain soap and water, though the latter is a bit slow in taking off the stain. If the skin has been very much broken by scratching or otherwise and is raw, the oxalic acid will cause a temporary stinging and soap and water is preferable for removing stains from such sensitive surfaces. If the skin is very tender, the solution of potassium permanganate may be diluted with water before using.

"The permanganate treatment is recommended only as a remedy for poisoning that has already taken place. Persons who know that they are likely to be poisoned may prevent the plants from harming them with a wash devised by Dr. James B. McNair, of the Field Museum, Chicago. This consists of a 5 percent solution of ferric chloride in a fifty-fifty mixture of water and glycerin. This is to be washed on all exposed parts of the skin and allowed to dry there, before going where the dangerous weeds grow. The iron in the chemical combines with the poisonous principle of the ivy and changes it into a harmless, non-poisonous compound.

"This 'iron cure' has been thoroughly tested by professors and students of the botany department at the University of Chicago. Their field trips take them through much poison ivy and poison sumac country, especially in the famous Lake Michigan dunes. Before they began to use Dr. McNair's treatment, ivy and sumac poisonings were taken as a part of the natural hazards of a scientific course, but now they are rare occurrences.

"Dr. McNair disclaims credit for the first discovery that a solution of an iron salt will help in the treatment of ivy poisoning. Indeed, it would be hard to think of something to put on an ivy-blistered skin that has not already been tried, for the more or less authentic remedies he lists in his monograph run literally into the hundreds. Common copperas, which is sulphate of iron, is used in some parts of the South, and iron salts were suggested by physicians many years ago.

"But Dr. McNair was the first man who extracted the poisonous principle of the plants in a concentrated form, anaylsed it chemically, and found that when mixed with an iron solution it became insoluble and was no longer poisonous. His claim to recognition therefore rests on the fact that he first firmly established the 'iron treatment' of ivy poisoning on a solidly scientific basis, especially as regards its value as a preventive.

"Poison ivy is more of a terror than it has cause to be, for all scientists who have studied the subject agree that many persons, perhaps even a majority, are more or less immune to it. No one, says Dr. Couch, is absolutely ivy-proof; he can raise blisters with the squeezed-out sap of the plant on the skin of any one hardy (or foolish) enough to volunteer for such an experiment. But many of these same persons can walk around in it all day, or pull it up by the handsful, with no ill effect whatever.

"But this should not encourage these lucky ones to be too reckless. Immunity to poison ivy does not always stand at the same level, but apparently suffers occasional let-downs, and if one happens to get poisoned during one of these low spells he never recovers his lost immunity, but remains susceptible for the rest of his life.

"Dr. Couch states also that ivy poisoning is really a double effect. The blistering and itching are caused, he says, by the substance which Dr. McNair isolated and named 'lobinol,' and the swelling and reddening of the afflicted parts, together with the general 'all-gone' sick sensation that so seriously affects many poison-ivy patients, are what is known as an 'allergic' reaction, more or less analogous to most kinds of hay fever, and are probably due to some other poisonous substance not yet identified. Persons who are susceptible to the blistering effects of the ivy are often quite immune to this allergic reaction.

Its fruits are smooth, round, white berries that hang in drooping loose bunches, while the ornamental sumac's fruits are small and rough, dark brown in color, and stand erect in close pyramidal clusters. The bark of poison sumac is pallid gray, while that of the common sumac is brownish, or very hairy and sooty-black. Poison sumac is reported to be worse in its effects than poison ivy, but dangerous to fewer people

For this part of the poisoning effects the various chemical treatments recommended for the blisters and itching are of no use; all the patient can do is go to bed and keep quiet until he feels better.

"But after all has been said about remedies and preventives and the fortunate immunity of many persons, the best prescription for poison ivy and its relatives is to know them when you see them, and

Starting out for the scene of a motor accident. These two officers of the only automobile homicide squad in the United States are equipped for obtaining photographic and other evidence. A camera and its accessories, and a portable typewriter permit taking evidence on the spot of the accident

Another Transmutation Experiment Fails

THE dream of the ancient alchemists, thought to have been realized by the transmutation of hydrogen into helium by Drs. Fritz Paneth and Peters, noted German chemists, has had to go back to the status of a dream once more, according to a report in the German scientific journal *Die Umschau*.

Prof. Paneth has himself retracted the claim that he changed one element into another, because of the discovery of two hitherto unsuspected sources of error in his apparatus. Ultra-minute quantities of helium were held absorbed in a mass of asbestos, used in the apparatus, and a still smaller amount was dissolved in the glass tubing. These hidden traces of gas came out when heated, and infinitesimal in amount though they were, they registered their presence and thus led to the mistaken impression that helium had come into existence where none had been before.

Prof. Paneth recently spent several months at Cornell University as non-resident lecturer in chemistry and much of his time was spent in research upon the problem of transmutation. His experiments were also repeated in the chemical laboratory at Princeton University with his cooperation. The Princeton chemists are understood to have been unable to bring about the transmutation of hydrogen into helium.

—*Science Service.*

"Ice Concrete," a Remarkable New Building Material

"ICE CONCRETE" is the name of a new, porous and light building material recently invented in Finland. This new substance is made of cement and sand, like any other concrete, but it differs greatly from ordinary concrete in that it has been made extremely porous by mixing it with crushed ice and snow. Then the moisture is evaporated through heating. By this process the block or the brick is honeycombed evenly by tiny pores. No additional water in composition is needed since the water required is formed through the melting of the ice or snow.

The degree of porousness of this concrete can be accurately determined in advance by the quantity of ice or snow used. Consequently, the weight of the material is in direct relation to the number and the size of the pores. It is possible to use as much as from 50 to 80 percent of ice or snow in the mixture, thus producing millions of minute pores throughout the material. In Finland, Sweden and Denmark numerous buildings have been erected, using ice concrete.

Only Auto Homicide Squad in the United States

WITH the increasing hazards of every-day motoring, Traffic Commissioner Edward J. Donahue of the Cleveland police department has organized a special Homicide Squad in hopes of curbing deaths which have been caused by careless drivers. The squad, which is the only one of its kind in the country, is supplied with complete photographic equipment, including a darkroom for developing pictures taken immediately after accidents, two offices and complete files for keeping records.

There is always a sergeant and one patrolman on duty awaiting the call that a serious accident has occurred. Both men are trained in the use of cameras and draughting materials for making sketches.

When an accident has occurred, these officers start out in their own motor car, one taking a camera and the other a portable typewriter. Arriving on the scene, they take pictures from every angle, a complete report is typed on the spot and all available witnesses, including the drivers and occupants of the cars involved, are brought to the office of the squad.

Forty-three drivers have already been convicted for manslaughter. Convictions for careless driving and failure to stop after accidents run into hundreds.

Police Prove Long on Brain Power

ONE California town, at least, has a police force with intelligence averaging higher than that of college freshmen and army officers. This announcement, following on the heels of statements that policemen in American cities are short on brain power, is the result of an investigation made at Palo Alto, California, by Maud A. Merrill, of the psychology department of Stanford University.

The investigation was designed to find out whether men of comparatively high intelligence and ability make good policemen and are satisfied with the work, Miss Merrill reports in the *Journal of Personnel Research.*

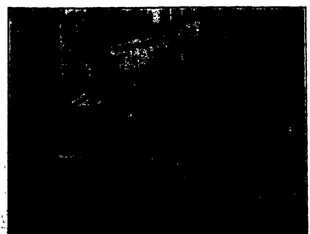
For two years, each applicant for the Palo Alto force has been given the Alpha intelligence test used to grade the mentality of United States soldiers during the war. Out of 113 applicants, 30 were chosen on the basis of their intelligence, together with the impression they made on the examiners.

"The average Alpha intelligence score of men who have remained on the Palo Alto police force for two years is 143.5, a score higher than the average for army officers and higher than that reported as the freshmen average at many colleges," says Miss Merrill.

"The median score of men who have been discharged for inefficiency or for conduct unbecoming an officer is 137. Men who left voluntarily for better jobs have a median score of 171.5. One of these men left the police force to go into grand opera."

The median Alpha score made by white drafted soldiers was about 60.

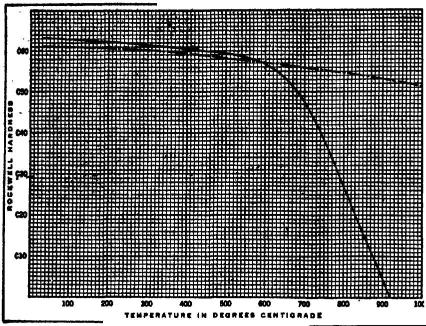
—*Science Service.*



A machine for mixing and casting porous "ice concrete" blocks. The process consists of mixing concrete with crushed ice or snow, casting the blocks, and removing the moisture by heating. This method produces blocks which are porous to a degree depending on the amount of ice or snow entering into the original mixture

Extremely Hard Alloy Defies Wear

HOW the revolving cutter of a hydraulic or suction dredge was protected with an extremely hard alloy called "stellite," which resists wear to a



In this curve, the red hardness of stellite is compared with that of high-speed steel. Dotted curve represents stellite; solid line represents the steel

remarkable degree, is explained in a recent issue of *Oxy-Acetylene Tips* (New York). These cutters work deep in the mud, clay, sand and gravel of harbors and are ordinarily subject to extreme wear, necessitating frequent replacement. But when coated with stellite, their life is multiplied several times. Stellite is an alloy of chromium, cobalt and tungsten. It retains its hardness up to a temperature of 1830 degrees, Fahrenheit, long after steel tools have softened, and for this reason it is frequently used for machine tools. Says *Oxy-Acetylene Tips:*

"As the cutter loosens the dirt, it is drawn into a suction pipe by a powerful centrifugal pump, and then forced out through the discharge pipe to the point of disposal. Obviously the cutter blades wear very rapidly, replacement is an ever-present problem, increasing in seriousness as the dredges are used in more remote localities.

"Recently a dredge was sent to a South American harbor. It was known that the digging was such that the life of the rotary cutter would be only about six weeks. As this is a steel casting about four feet in diameter and four feet long, weighing about 3500 pounds and worth 800 dollars f. o. b. the American foundry, the question of a duplicate for replacement immediately arose.

"Each of the six cutter blades is about 12 inches wide, the cutting edge being three eighths of an inch thick, increasing to about one inch at the rear end. Use wears the blades down until four or five inches wide, when replacement is necessary.

"In view of the expense of the cutter, and the possible delays in delivery, it was proposed to protect the cutting edges with stellite.

"For this purpose a band of stellite about four inches wide and 25 inches long was to be applied along the inside and outside faces of the cutting edge of each blade. (This stelliting process is based on the fact that stellite melts at a lower temperature than steel and adheres very tenaciously when properly applied. It is used in the form of welding rod and an oxy-acetylene blowpipe furnishes the heat necessary.

"As will be evident from the accompanying illustrations, welding was complicated to a certain extent by the curvature of the blades, which made it necessary to change the position of the cutter at brief intervals. The stellite coating was three-sixteenths to one-quarter of an inch thick, 150 pounds of the alloy being required for the six blades. The casting was very rough and had been painted, all of which tended to impede the operation. It therefore took about 105 hours to complete the work.

"This protecting layer brought the total cost of the cutter up to 1700 dollars, a little more than twice the cost of the unprotected casting."

Further interesting facts about stellite appear in a booklet published in Kokomo, Indiana. While the fact that stellite retains its hardness up to 1830 degrees, Fahrenheit, is a great advantage—in fact, one of the principle advantages of the alloy—this advantage actually militates against the material when it comes to working it, for the hardest grade of stellite can neither be forged nor machined; grinding is the only method of modifying the shape of the casting. However, a softer variety of the alloy is made, which can be rolled, forged and stamped at the temperature named; this is comparable to the harder variety in resistance to abrasion and corrosion but is inferior in hardness.

Stellite is deposited on metal by the process of fusion welding, as shown in the accompanying illustrations, and the process is best accomplished by the oxy-acetylene flame. The relative resistance of stellite, as compared with steel, varies from four to nine times. Most acids and reagents do not attack it. Among its varied uses are for well drill-bits, dentists's instruments, dies, knives, and machine tools. It also has been considered as one of a number of candidates for the material from which the mirror of the projected 12,000,000 dollar, 25-foot reflecting telescope might be made. Its reflecting power is 68 to 83 percent; that of silver, 68 to 95 percent.

How the alloy stellite was fused to the steel knives of the cutter of a hydraulic dredge, with a torch

The knives of a large dredge cutter, protected against rapid abrasion by a deposit of stellite alloy

INDUSTRIES FROM ATOMS

A Department Devoted to the Advancements Made in Industrial and Experimental Chemistry

CONDUCTED BY D. H. KILLEFFER

Boll Weevil Control

THE ever pressing problem of protecting growing cotton from the ravages of the boll weevil has been given serious study by members of the Chemical Warfare Service at Edgewood Arsenal, with the result that much light of great probable value has been shed upon it. Investigations involving more than 1000 possible poisons and poisonous mixtures and their action on more than 150,000 boll weevils are reported in a recent number of *Industrial and Engineering Chemistry* by H. W. Walker and J. E. Mills. While this is merely a progress report, it shows that 22 materials possess a toxicity for the boll weevil greater than that of calcium arsenate, now considered the standard, and cause less injury to the plant itself.

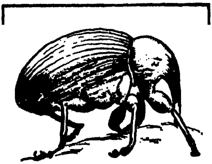
In discussing this investigation, an editorial in the same issue of *Industrial and Engineering Chemistry* states:

"One interesting result of investigations made by the Chemical Warfare Service looking to the better control of the cotton boll weevil has been the development of a process which promises calcium arsenate in acceptable physical form at lower costs. The extent to which the cotton farmer can employ calcium arsenate is determined by the price of cotton and its relation to the price of this chemical compound. While both prices fluctuate between wide limits, it is obvious that a uniformly low-priced arsenate would encourage its more frequent and extensive use, thereby affording a more complete control of the boll weevil and consequent lower production costs for the cotton farmer. The perfection of the process is another indication of the peacetime utility of the Service."

The investigations included not only materials which might be poisonous to the weevils but also studies of odors and flavors that might attract or repel them and of various irritants that might drive them away. In stating their conclusion, these investigators summarise their findings as follows:

"1—Commercial sodium fluosilicate is more toxic to the boll weevil than commercial calcium arsenate on a volume basis, but on account of the greater apparent density of the fluosilicates, it requires from two to four pounds of them to cover effectively the same area that one pound of commercial calcium arsenate will cover. These commercial fluosilicates show some injury to the cotton plant. So-called "light" and "extra light" commercial materials containing less sodium fluosilicate are still too dense from the standpoint of covering power, and their effectiveness is decreased with the lowering of the Na_2SiF_6 content. Also, the plant injury is decreased. When the Na_2SiF_6 content is reduced much below 80 percent, the material is not so effective as calcium arsenate.

"2—A special fluosilicate made at Edgewood Arsenal, containing about 80 percent Na_2SiF_6 and 20 percent SiO_2, is at least as effective on a pound per pound basis as calcium arsenate, and the plant injury caused by it is of low economic importance.



This large drawing shows the boll weevil, an insect which the science of chemistry is combating successfully by the methods described

"3—Barium fluosilicate, made in the same way as the sodium fluosilicate, containing about 90 percent $BaSiF_6$ and 10 percent SiO_2, is about as effective on a pound per pound basis as calcium arsenate and causes no appreciable plant injury. The toxicity of the barium fluosilicates in general is somewhat less than that of the sodium fluosilicates.

"4—When the dust is applied to the plants five days before the weevils are um fluosilicates cause at least as great weevil mortality as freshly dusted calcium arsenate. Calcium arsenate applied five days prior to the introduction of weevils in the cage causes appreciably lower mortality than freshly dusted calcium arsenate. In these tests the cages were covered to prevent rain from washing the dust off the plants.

"5—Specially prepared calcium arsenate containing only 24 percent arsenic as As_2O_5, the arsenic being contained mainly in the coating of each particle, is equally as effective as commercial calcium arsenate and was non-toxic to the plant in these tests. Calcium arsenate similarly prepared, containing only 10 percent As_2O_5, wa less effective than commercial calciur

[illegible] senate may [illegible] tain any desired percentage of arsenic as As_2O_5 by heating the requisite amount of As_2O_3 with precipitated chalk in the presence of air at a temperature of about 650 degrees, Centigrade, for one hour or less.

"7—Barium fluoride and cryolite are at best only slightly less effective than calcium arsenate on a volume for volume basis and cause no appreciable plant injury. They require an increased poundage per acre over calcium arsenate, however, and no economical means of adapting their physical properties to overcome this has yet been devised.

"8—While small percentages of As_2O_3 adsorbed on coal dust showed definite weevil toxicity and practically no plant injury, they were not so effective as calcium arsenate. When these percentages were increased, they caused definite plant injury without raising the weevil toxicity to a point equal to that of calcium arsenate. Four percent of arsenic trioxide on coal dust killed the plant. Arsenic trioxide is definitely more toxic to both the plant and the weevil then arsenic pentoxide.

"9—Very insoluble organic arsenicals of known high general toxicity, such as diphenylamine chloroarsine, diphenylamine arsenious oxide, diphenyl arsenious oxide, et cetera, were at best only slightly toxic to the boll weevil, owing probably to their low solubility.

"10—Preliminary tests indicate that the fluosilicates in molasses mixtures are at least as toxic to the boll weevil as calcium arsenate in molasses mixtures. It is further indicated in tumbler tests that molasses mixtures of calcium arsenate are about as toxic to the weevil as calcium arsenate dust.

mixture containing the same amount of calcium arsenate.

"11—Unfavorable weather and crop conditions made it impossible to make trustworthy comparisons of the relative effectiveness of the fluosilicates, the special calcium arsenate, and commercial calcium arsenate from the one-acre plot tests made to date. All these materials showed definite weevil control and there was no plant injury apparent on field cotton in any case. It is hoped to establish the relative effectiveness of these materials during the present year.

"12—There is little hope of poisoning the boll weevil in the field by the use of volatile gases.

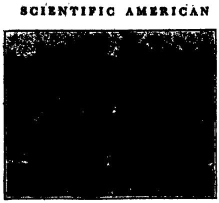
"13—The following are various estimates pertaining to the weevil:

- Average weight of a boll weevil (does not include undersized weevils) 15.0 milligrams.
- Amount of air breathed by a boll weevil per hour, 0.33 cubic centimeters.
- Minimum arsenic required to kill a boll weevil, 0.00013 milligrams*.
- Average arsenic content found in weevils killed with calcium arsenate, 0.002 milligrams.
- Amount of water a weevil drinks per day, 0.02 cubic centimeters.

*Possibly too high.

"14—No substances were found which definitely attracted or repelled the boll weevil. No substances were found which irritated the weevil sufficiently to make it fly.

"15—In carrying out the directions of the Association of Southern Agricultural Workers and the Department of Agriculture for boll weevil control, the following suggestion is made: When the initial weevil infestation is below twenty weevils per acre or when it is, or has been, reduced to local infestation, the fight should be continued against the individual weevils both by local poisoning and by picking up the fallen punctured squares locally, as necessary, to insure the most complete control possible. Advanced cotton and badly infested cotton should receive special attention in order to prevent multiplication of the weevils in these local spots and later infestation of the entire crop. Success in the fight against over-wintered weevils will give complete security against any large amount of weevil damage."



The three drums show the amount of water drained from a normal trailer-load of garbage. The removal of this weight greatly facilitates transportation and allows more material to be carried in one of the trailers that are used

Profitable Garbage Disposal

THE municipal garbage-disposal plant at Indianapolis, treating 32,000 tons of garbage annually showed a profit of 29,000 dollars on the operation during 1926, according to Harrison E. Howe in a recent article in *Industrial and Engineering Chemistry*. Mr. Howe begins his discussion by asking this question: "Is the garbage of an American city a material so valueless as to merit only complete destruction by fire, or is it a waste worthy to be classed as a raw material capable of yielding a profit when treated in accordance with most modern procedure?" He finally makes this statement: "It seems to have been demonstrated that when properly processed, American city garbage is a material well worth working for its values and that this step in conservation can be widely recommended."

The crux in the matter of profit seems to have been the use of the newly developed McCullough-Nolen dewatering device in collecting garbage and improvements in its treatment. "This," according to Mr. Howe, "consists in the use of metal trailers for the collection of the city's garbage, these trailers being provided with a false bottom which accomplishes dewatering to a remarkable degree. There is simply a perforated plate over the entire bottom of the trailer, and as the garbage is dumped from each household container and the trailer travels along the alley route to the next house, the water is shaken out and drains into the receiving compartment in the bottom of the trailer. To empty the water compartment, the garbage collector opens a standard two-inch molasses cock, and drains the trailer into any convenient sewer manhole. In the course of collection, the compartment may be drained three or four times and as much as 200 gallons of free water may thus be eliminated without expense and to considerable advantage.

"The advantages include the elimination of some of the hazards of garbage collection, less odor and fly nuisance, and particularly the complaints of the residents as to the spillage of garbage along alleyways and streets. The load is comparatively dry and when covered with a tarpaulin is no more objectionable than any other truck or trailer passing through the streets. By eliminating this water, larger loads can be hauled and the capacity of the reduction plant is increased, the garbage is received at the plant in better condition for reduction, a large part of the odors about the reduction plant is prevented and the dewatered garbage gives better products, which in turn means a larger profit on operation. The small amount of grease lost with the water is of no moment in the face of these benefits.

"The trailers previously described are delivered at a receiving station which has a capacity of 400 tons of green garbage. The floor of this station is so designed as to permit the dewatering of green garbage to continue before being conveyed to the digesters. A special power scraper, making unnecessary the twelve men otherwise required to shovel the green garbage to the conveyor, has been installed and serves to move the mass to a floor conveyor."

The garbage thus collected and dewatered is passed over a magnetic pulley to remove iron and is then conveyed to rendering tanks where it is steamed to remove grease. The recovered grease has a ready market. The residue in the digestors is dried in a vacuum before its removal. A unique arrangement removes foreign matter from the prepared tankage and turns out a product containing less than 0.1 of 1 percent of glass and china and no free metals.

Bits of china, metal and the like, often found in garbage, must be removed at the disposal plant. The illustrated machines, called separators, accomplish this work

Learning To Use Our Wings

This Department Will Keep Our Readers Informed of the Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN
charge, Daniel Guggenheim School of Aeronautics, New York U

Lindbergh's Transatlantic Flight

COLONEL CHARLES A. LINDBERGH left New York on Friday morning, May 21, at 7.52 A.M. and reached Paris on Saturday, May 22, at 5.24 P.M. Eastern Standard Time, after flying for approximately 33½ hours and covering about 3650 miles. The average speed of the flight was about 109 miles per hour, somewhat faster than he had estimated. There is no doubt that following winds favored the flight to some extent.

Barring some fog, overcast conditions and perhaps slight precipitation in the vicinity of the icebergs, the experts had predicted fair weather in the mid-Atlantic, and only slight rain in a region of low pressure near Paris. Head winds slowed down the plane in the early stages of the flight, but this was more than compensated for later on. On the whole the experts' predictions worked out well. The fog proved no insurmountable obstacle: "I expected trouble over Newfoundland," said Colonel Lindbergh, "because I had been warned that the situation was unfavorable. But I got over that hazard with no trouble whatsoever. However it was not easy going. I had sleet and snow for over 1000 miles. Sometimes it was too high to fly over and sometimes too low to fly under, so I just had to go through as I could. I flew as low as 10 feet in some places and as high as 10,000 feet in others." At the end of the flight enough fuel remained for another 500 miles.

Lack of sleep did not bother the extraordinary aviator. A couple of sandwiches and a little water were rations enough; he counted on hunger to keep him awake.

He struck the coast of Ireland almost exactly at the plotted point, was escorted over the English Channel by a squadron of British planes, and had no difficulty in locating Le Bourget, guided by forty French flares.

The tremendous ovation awarded to the unconcerned young man, and the world-wide enthusiasm aroused, will remain forever in aeronautical history.

Before Lindbergh's wonderful flight, expert opinion had been inclined to favor the chances of Byrd's *America*. Byrd had a three-engined plane and therefore greater power-plant reliability; two pilots, relieving one another at need; better vision and accommodation in the pilot's cockpit; a skilled navigator and all the instruments necessary for sighting the sun and checking position; a better supply of food and water; and above all human companionship. His expedition was also better prepared for accident with rafts, radio, signal flares, and a carefully rehearsed plan of action in case of accident.

If the *America* had succeeded, its triumph would have been perhaps a more convincing precursor of the commercial conquest of the Atlantic. However, Lindbergh's success proved that personal skill and courage could offset somewhat greater engineering facilities. It must not be thought, however, that the gallant aviator was not fully prepared. He had worked long and earnestly, and to great courage was joined excellent equipment and much forethought.

The Engine Used

He had in the air-cooled Wright J engine or "Whirlwind," as it is picturesquely termed, a well-tried mechanism of remarkable lightness, efficiency and endurance. The design of this engine was begun on February 28, 1920. It has passed through a long development in successive models; the J-1, J-2, J-3, and J-4. The J-5 successfully met the rigid endurance tests of 50 hours at full throttle—far more severe than the requirements of actual flying. In one extraordinary 50-hour test, conducted in the hottest part of the summer, the average temperature was 150 degrees, Fahrenheit, at the point of entrance to the carburetor, and the power averaged 295 horsepower at 2150 revolutions per minute, although the normal rating of the engine was only 200 horsepower at 1800 revolutions, and the weight dry was only 508 pounds. Moreover, the Wright Aeronautical Corporation had the advantage of service tests in many Army and Navy planes, and of almost universal employment of their engines in commercial planes such as the Fokker, Ford, Keystone, Laird and Sikorsky. Among other records, the spectacular endurance test of April 12-14, when a Bellanca plane stayed aloft for 51 hours, 11 minutes and 25 seconds, with a stock engine which had already had some 179 hours of flight, was but a confirmation of the engine's reliability. Its fuel economy was moreover equal to that of the very best engines ever built. On the flight to Paris, the fuel consumption averaged less than 13 gallons per hour or over eight and one-half miles to the gallon. Even granting the following winds which favored the flight, this is a remarkable record of efficiency.

The actual fuel statistics of the transatlantic flight as given in a cable by Lindbergh were as follows: "Consumption checked only to-day. Fuel, 432 gallons, oil 11.8 gallons. Average revolutions per minute of the propeller 1600. Throttled down after take-off. Open to 1800 when climbing over sleet. 'Whirlwind' engine functioned perfectly during entire flight from San Diego to Paris, and was in as good condition at Paris as at San Diego." The engine was therefore close to its rated revolutions per minute throughout the flight.

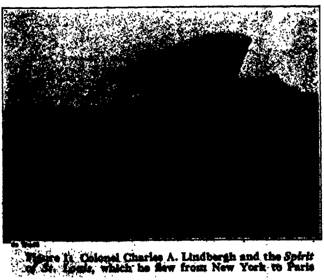


Figure 1: Colonel Charles A. Lindbergh and the *Spirit of St. Louis*, which he flew from New York to Paris

Figure 2: The instruments which guided Lindbergh safely to Paris. Their various uses are indicated above

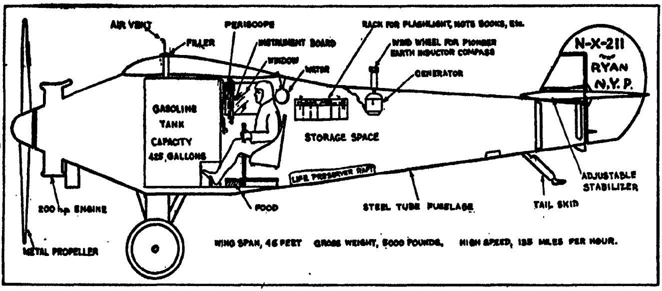


Figure 3: A cross-section view of the *Spirit of St. Louis*, showing the placement of the more important parts of the equipment of the monoplane. The position of the gasoline tank gives safety in case of a crash

The Ryan Monoplane

The *Spirit of St. Louis*, see Figure 1, was a stock monoplane model built by the Ryan Airlines of San Diego. The only alterations made were in the addition of ten feet to the wing span, increasing it to 46 feet; in fairing up the ship in every possible way, such as bringing the strut ends smoothly into the wings; in placing the huge gasoline tank of 425 gallons capacity in lieu of the passenger compartment, and in totally enclosing the pilot's cockpit. The enclosing of the cockpit was intended to improve the speed and fuel economy, since the slightest break in the fuselage means additional air resistance. That it achieved these ends is shown by maximum speed of the craft, estimated at 135 miles an hour, and by the fact that at the end of the flight, fuel for 500 miles remained.

Speed and economy were purchased indeed at the expense of diminished vision. As seen from our diagram in Figure 3, Lindbergh could see only through a small aperture in front which he called his "periscope," or through the window at his left.

The plane fully loaded for the trip weighed 5200 pounds. This meant a loading of 26 pounds per horse-power and with a wing area of about 320 square feet, a loading per square foot of wing of 16.2 pounds. The plane had difficulty in getting off, touching ground twice before the final get-away, and showing the slowest possible rate of climb at the start.

The get-away probably offered the most hazardous moment of the flight. Had the sacrifice of vision not been made to get the last degree of aerodynamic refinement, Lindbergh might have failed to get clear. His boldness was fully justified. It is also an attribute to the sterling qualities of the Ryan monoplane that the huge overload was sustained without structural modification other than the increase in wing span, and that the gross weight of 5200 pounds is the largest ever sustained by a 200 horsepower engine.

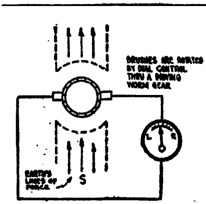
The Cost of the Equipment

The actual cost of the Ryan monoplane was 6000 dollars. It was built and ready to fly in 60 days. The instruments and the engine cost 6900 dollars, bringing the total equipment cost to 13,000 dollars. This can hardly be considered expensive for the result achieved.

Lindbergh's Plan of Flight

To people who knew how carefully Commander Richard E. Byrd had planned to navigate, taking sextant observations every half hour, and how difficult is the problem of piloting a plane on a straight course over water, where there is nothing on which to sight, it appeared that Lindbergh was taking a tremendous chance in depending upon dead reckoning alone. His spectacular flight at night, from San Diego to St. Louis, did much to dispel these doubts. At the end of the 1600 mile flight, he had found himself only 15 miles off St. Louis, having successfully allowed for drift, magnetic variations and the special deviation of his compass.

Lindbergh set out with the fullest confidence in his ability to navigate the Atlantic. We must quote his own words as to his plans: "People forget that I will be able to check my course by the map all the way from New York to Newfoundland. Even at night I could do that, for unless the night is very dark it is possible to distinguish water from land. On a moonlit night it is very easy. The most difficult hours of the flight, the first 14, will be over land most of the way, and if I can get a good sight of the coast of Newfoundland as I leave it, I should be able to get my bearings with some degree of accuracy. The worst compass variations also are on the way to Newfoundland. From there on over the ocean, the variations are not more than two to four degrees. That is not bad. I can easily allow for them and even granting that I make the worst possible error, an error of four degrees, it would only put me 100 miles off my course. The question of drift is a different thing. It is very hard to tell just what one's drift is over water, for there does not seem to be any motion at all unless it is very rough. But I will carry smoke bombs and with the drift indicator it should be possible to get some idea of the direction of the wind and the effect it is having on the plane."



the earth inductor compass functions. A description is given in the text on the opposite page

Lindbergh would not have been able to use a sextant even if he had known how, as his cockpit was entirely enclosed, and he could not have obtained sights unless the sun was at his left, where he could stick his head out of the window. As events prove, his confidence in his ability to navigate by dead reckoning, (that is without sighting the sun or stars), was entirely justified.

It should also be pointed out that his instruments were adequate in every respect except as regards inclusion of the sextant, and that Lindbergh had not scorned to get the best technical advice in his detailed plan of navigation.

The Course as Plotted and Flown

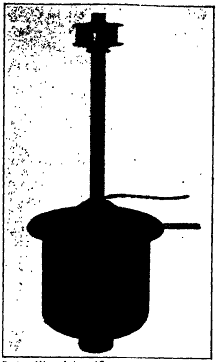
In particular he received assistance in establishing his course from Brice Goldsborough of the Pioneer Instrument Company. On the Hydrographic Office Chart of the North Atlantic, a great circle track was plotted, on which lay the shortest distance between New York and Paris. It may be of interest to note that great circle flying is not the usual method of navigation over land. In flying over land, the distances between points are very

much shorter and pure triangulation can be resorted to without appreciably lengthening the course.

But a statement by the National Geographic Society will clearly show why great circle flying was necessary in this flight. "Lindbergh was not going out of his way. He was making a bee-line for Paris. To non-seafaring folk, it is rather a surprise to note that the shortest course from New York to Liverpool lies across New England and Canada, west of Nova Scotia, and through inland Newfoundland. Ships cannot sail overland but they do veer as far north as the double obstacle of land and icebergs will permit. The reason for this, technically stated, is that in the higher latitudes the shortest distance between two points, because of the earth's curvature, is not on the east and west parallel, but on the arc of a circle which would divide the earth in two equal parts and pass through the points in question (a great circle).

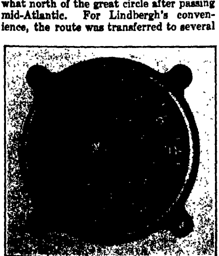
"A far simpler way to prove this is to take a piece of string and apply it to a globe. That piece of string will reveal more amazing facts about oceanic commerce than volumes of trade statistics. It will show why Norfolk, Virginia is a normal coaling port for all Europe-bound ' out of our Gulf ports. Looking at a flat map of the world, it would seem as if Lindbergh's shortest course would have been to fly out in an easterly direction from New York and past the vicinity of the Azores. Apply your string to a globe and you will find that the flying distance from New York to Paris, via Azores would be 4107 statute miles, whereas a course outlined by a string stretched tautly on the globe from New York to Paris, across New England, Canada and Newfoundland, and south of Ireland, the way Lindbergh flew, would be 3633 miles. Lindbergh flew that way to save 474 miles."

On the ideal great circle course, the actual distance between Mineola, New York, latitude 40° 44′ 18″ north, longitude 2° 20′ west, and Paris, latitude 48° 50′ north, longitude 2° 20′ east, was 3610.1 statute miles. The actual course which Goldsborough advocated for Lindbergh was slightly different. Considerations of steamship lines led to a course which was south of the great circle at the start and somewhat north of the great circle after passing mid-Atlantic. For Lindbergh's convenience, the route was transferred to several charts of large scale. Although Lindbergh had no way of checking his course at sea, he hit his destination "on the nose" on the Irish Coast. His skill in navigating by dead reckoning was truly miraculous!



Courtesy of Pioneer Instrument Company

Figure 6: The generator of the earth inductor compass system. This part is mounted near the tail, as shown on the preceding page



Courtesy of Pioneer Instrument Company

is set to the predetermined course which the pilot desires to follow

Lindbergh's Instruments

Excepting always the sextant, Lindbergh carried every possible instrument that could be of real service. The photograph of Figure 2 shows the interior of his cockpit, and the location of these instruments. The top of the throttle is in the lower right-hand corner, and in the extreme lower-right corner is the controller dial of the earth inductor compass. In the center is the control stick and underneath the board are the many valves by which the flier regulated the flow of gasoline from the main and auxiliary tanks. In the board above the instruments are, left to right, upper row: The oil pressure gage for watching of the lubrication system; the earth inductor compass; the altimeter for measuring height above sea level. Left to right, lower row: Ignition switch; tachometer for indicating the revolutions per minute of the engine; bank and turn indicator showing whether the ship was flying on an even keel, and also warning the pilot of minor deviations from his course; air-speed indicator and clock. In the lower center of the board the upright instrument is the fore and aft inclinometer; above it is the lateral inclinometer. The knob at the extreme right is the priming pump. Most of the instruments for the flight were specially made by the Pioneer Instrument Company.

In addition to these instruments, Lindbergh's craft carried an earth inductor compass. The angular variation between the readings of the magnetic field and the true north lies between 10 and 20 degrees. This variation or declination must be kept constantly in mind by the pilot, and corrections varied in accordance with location. When the ordinary compass is employed, there is the further difficulty that it is affected by the iron or steel which may be in its vicinity in the plane. In the earth inductor compass, current to actuate an electric meter is provided by the rotation of an armature in the earth's magnetic field, as shown in the diagram in Figure 4. The compass proper, see Figure 6, can be located at the very tail of the airplane where it is free from all magnetic disturbances of the metallic structure of the airplane but the controller, see Figure 5, by which the earth inductor compass is set to the desired heading, is placed in the cockpit where it may be operated by the navigator. The pilot has only to watch a meter, Figure 7, which shows any departure to left or right of the proper course.

For actual navigation Lindbergh had, besides his compass, his altimeter, air-speed indicator, drift indicator and smoke bombs. It is not yet quite clear that he used the smoke bombs in his flight. Certainly he intended to make use of them as the statement quoted above clearly indicates.

The air-speed indicator is extremely useful to the pilot because it gives him a general idea of the progress he is making, and warns him if he is flying too near to the minimum speed or stalling attitude. However, except in perfectly still air, it does not give the speed over the ground or sea. To get the ground speed and the the drift at sea, the following precedure is followed. A smoke bomb is dropped. The altitude is obtained from the altimeter. The speed meter is set at the indicated height, and the time of transit of the smoke bomb between two set pointers is obtained by sighting and use of a stop watch. The ground speed is then read directly from an appropriate scale.

In the drift meter proper, there is a vane index that passes over an arc divided in degrees. Normally the vane is neutral in the fore and aft plane of the aircraft. If, when sighting through the meter, the smoke bomb appears not to parallel the vane index, the vane is moved until a parallelism is established. Once this condition is established, the angle of drift can be obtained from the arc. Knowing his air speed, ground speed and drift angle, the navigator can easily calculate his exact course—sometimes with the aid of a device which is simply a mechanical means of solving all triangles. Lindbergh probably did not trouble to make exact calculations

(*Continued on page 181*)

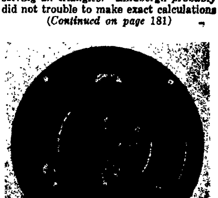


Figure 7: The indic[illegible] earth inductor compass [illegible] plane departs from the course indicated on the instrument shown in the left column, the needle of the indicator shows the departure

Radio Notes

A Monthly Review of Progress in Wireless Communication

CONDUCTED BY ORRIN E. DUNLAP, JR.

Power Transmission

INCANDESCENT lamps, held or suspended in the air without any connection to electric-power wires, were made to glow brightly when high-frequency waves were directed upon them, in a demonstration of power transmission by radio by two Westinghouse engineers, Dr. Phillips Thomas and Dr. Harvey C. Rentschler, before the New York Electrical Society.

Dr. Rentschler displayed a radio furnace in which chemical reactions were caused by radio waves. Metallic tungsten, among the most infusible of metals, was heated white hot in an instant by the invisible rays.

It was made clear that radio waves like those used in broadcasting, except of shorter wavelength, can be reflected from metal mirrors and confined to narrow beams, in much the same way as the beams of light from an automobile headlight. "We may visualize," said Dr. Thomas, "a parallel beam of radiation ten centimeters, or four inches across, along which is being sent 10 kilowatts of energy. What sort of effects shall we find? Will this be the means for delivering energy for heat and light to individual houses? Improvements in the radio art make it interesting to consider such a possibility. We may imagine each house furnished with a half-wave oscillator in line with a parallel beam from a sending station, so that the heat and light may be obtained very much as at present, by simply turning a switch but without the costly wire transmission equipment now necessary."

Dr. Thomas, before the Electrical Society, generated waves of this type as short as 240 centimeters, or eight feet, which is only about one-hundredth of the wavelength of the shortest waves ordinarily used in broadcasting. He predicted that still shorter waves would be produced, capable of being concentrated into narrow and powerful beams.

The radio furnace demonstrated by Dr. Rentschler is designed to concentrate a large amount of radio power within a very small space. Certain metals cannot be prepared usefully in metallic form by ordinary methods because they are combustible when in the state of fine powders, burning in the air like tinder whenever they are heated. The radio vacuum furnace had made these peculiar metals available, and it is expected that uses will be found for them in industry, according to Dr. Rentschler. He pointed out that one use for the radio furnace would be to turn metals like gold and silver into gases so that their individual atoms might be weighed.

Old Instruments Coming Back

BROADCASTING has brought plenty of forgotten musical instruments into prominence, and has helped to popularize the development of a host of new ones. According to the radio impresarios, the process will continue just as long as musical tools which register through the microphone with new tonal qualities can be discovered or created.

The program director at WEAF is no longer amused when the artist produces from his pocket an instrument bearing a strange seven-syllabled name, or when he states that a truck is outside laden with a musical implement whose name can be recorded in three letters.

Many of the weirdly named instruments are old ones. Others have come recently on the market, but these are usually adaptations or mechanical variations of ancient musical tools. Some of them have proved unsuited to broadcasting, but plenty of them have made established places for themselves in the ranks of instruments well suited to microphone work.

Before the advent of broadcasting, few people had heard of the celeste, although it had always been a part of every full symphony orchestra. The instrument consists of a number of steel plates which are played by being struck with small hammers, a description which sounds considerably less melodious than the sweet tones which the celeste produces in broadcasting. Today the instrument is being used by many popular orchestras in their concerts over the air.

The xylophone, the marimba and the cymbalum, all implements similar in construction to the celeste, have also been brought to fame largely by radio, and the vibraphone, which produces its tones from metal tubes rather than from strings or disks, has been designed especially for broadcasting purposes.

"Almost anything can be played these days," said H. T. Martin of WEAF. "Witness the sweet, swinging tones of a saw when struck with a padded hammer and bent to produce various notes. The cigar-box banjo and the 'one-string fiddle,' made from a cigar box and a broomstick, in the hands of experienced players produce real music of a startlingly 'different' character when heard over the air.

"Other instruments which have proved excellent broadcasters are legion. They include the zither, a form of Irish harp once very popular but little heard of late, until broadcasting came into its own. The dulcimer and the harpsichord, forerunners of the modern piano, are making new musical reputations, thanks to the microphone. Even the jew's-harp is gathering laurels for itself."

New Condenser

A RADICAL departure in the standard design of rotary variable condensers has been introduced by the Unicontrol Condenser Corporation. The new pre-

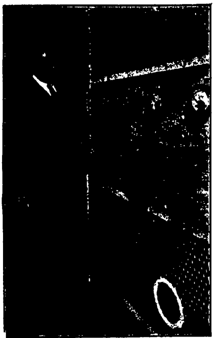
(*Continued on page* 172)

New York Electrical Society

Twenty-four meter transmitting circuit developed by Dr. Phillips Thomas to send power through space in sufficient quantity to light incandescent lamps held suspended in space, thus demonstrating power by radio

Visual picture of radio waves as demonstrated by Dr. Phillips Thomas. The whitish line representing the wave form is produced by a rapidly vibrating rope, set in vibration by means of a small electric motor

cision instrument differs from the old style of stamped plate condenser in that the rotor and stator plates consist of two integral castings. They are proportionally small in size to their capacity, requiring less mounting space; and, while manufactured of a special aluminum alloy which makes them less in weight than the average condenser, there is no possibility of warping or distortion of the plates.



Harvey T. Rentschler, director of research, Westinghouse Lamp Company, with his "radio furnace" used to produce high temperatures by means of high-frequency waves

A special tapering arrangement of the plates is a paramount feature, which allows a perfect straight-line frequency and wavelength without the use of offset plates. An exclusive feature is the capacity adjustment, which permits the condenser to be adjusted individually to the coil after mounting in the receiver, which assures a well-tuned set.

The instruments are manufactured in two types, ranging in capacity from .00025 to .0003 microfarads in the three-plate series and .0003 to .0005 microfarads in the four-plate series. There are no soldered joints or pins; and, therefore, there is no chance for loose contacts or corrosion. By a novel bearing arrangement of the shaft, an even motion of the rotor is assured. Simple provision has been made for mounting the condenser on the panel, and the instrument itself carries suitable terminals for circuit connection.

New Tube Designed for Amplifier Unit

A NEW tube designed to give increased volume in resistance-coupled audio-amplifier circuits has been introduced by the E. T. Cunningham, Inc., to be known as the CX-340.

General operating specifications of the tubes are as follows: Filament voltage, 5.0 volts; filament current, .25 ampere; recommended "B" voltage, 135 to 180 volts, and amplification factor (*mu*), 30.

The CX-340 is a storage-battery tube, with a one quarter ampere, long-life filament of thoriated tungsten. A standard CX base is provided. This tube is intended to give the highest practicable voltage amplification so essential in the resistance-coupled amplifiers. This method of amplification, in contrast with the transformer-coupled method, depends entirely upon the tube for the step-up effect. In transformer coupling, on the other hand, the step-up effect is brought about by the transformer ratio as well as the tube. Therefore, the CX-340 and its equivalent, the UX-240, have been designed to provide an amplification factor of 30.

The over-all amplification of one stage of resistance-coupled amplification, employing the CX-340, is said to be substantially equivalent to the average stage of transformer-coupled amplification utilizing the UX-201-A. This is contrary to general belief which holds that resistance-coupled circuits give such poor amplification that an additional stage or two are necessary to produce satisfactory volume. When a general-purpose tube of moderate amplification is employed, this is admittedly the case. It may also be the case when tubes of a lower *mu* than 30 are employed. But with the CX-340 or equivalent tube in the detector stage as well as in the first stage, there is adequate output to operate a power amplifier at full efficiency.

With the exceptional amplification factor (high *mu*) of the new tube, it becomes possible for amateurs to reduce the resistance-coupled amplification to two stages, namely, the first stage with this tube following the detector employing the same type tube, and the second stage with a power amplifier. The cost of the condenser, plate coupling resistor and grid leak employed in each resistance-coupled stage is only a fraction of the cost of a high-quality transformer.

Resistance-coupled circuits have heretofore been limited in popularity because of the high "B"-battery drain. This was true when the general-purpose type tube was misapplied to resistance-coupled circuits which call for a high *mu* tube. The "B" or plate current drawn by the CX-340, however, is about one-tenth that drawn by the average general-purpose tube employed in the same circuit, even when operating at "B" voltages of 135 to 180, which are essential for proper results with resistance coupling.

Rochester Favorites

IN reply to a question asked by *The Rochester Times-Union*, Rochester, New York, regarding what stations the radio listeners enjoyed outside their own city, the tabulated results show that WJZ led in a list of ten submitted as outstanding.

The following is a list of the ten leading stations and the percentage of replies received toward each: WJZ, 92; WGY, 83; KDKA, 79; WBZ, 77; WGR, 72; WPG, 70; WEAF, 68; WTAM, 62; WBAL, 60; and WLS, 58. The vote was specifically limited to stations outside of Rochester.

British to Print Programs in Braille

AN appeal for funds to enable the printing of radio programs in Braille for blind radio fans was recently broadcast in England by Captain Sir Beachcroft Towse, over the stations of the British Broadcasting Company. The project met with the approval of the National Institute of the Blind and the broadcasters promised their aid in giving out the program material in advance of regular publication so that the embossing in Braille may be accomplished in time. It is expected that if sufficient funds are procured, the blind radio fans of Great Britain will be supplied with the broadcast schedules at about $1.50 per annum.

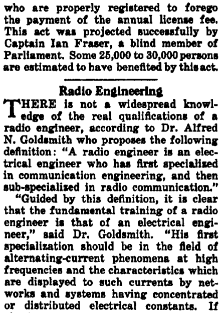
Another step, recently taken in England to insure the blind of radio entertainment, was the passage of an act which entitles all blind radio listeners who are properly registered to forego the payment of the annual license fee. This act was projected successfully by Captain Ian Fraser, a blind member of Parliament. Some 25,000 to 30,000 persons are estimated to have benefited by this act.

Radio Engineering

THERE is not a widespread knowledge of the real qualifications of a radio engineer, according to Dr. Alfred N. Goldsmith who proposes the following definition: "A radio engineer is an electrical engineer who has first specialized in communication engineering, and then sub-specialized in radio communication."

"Guided by this definition, it is clear that the fundamental training of a radio engineer is that of an electrical engineer," said Dr. Goldsmith. "His first specialization should be in the field of alternating-current phenomena at high frequencies and the characteristics which are displayed to such currents by networks and systems having concentrated or distributed electrical constants. If elective courses on advanced transformer design and, under the division of physics, on acoustics, are available, the student will do well to choose these.

(*Continued on page* 180)



New York Electrical Society

A vacuum tube with which it is possible to produce intense heat by means of concentrated Hertzian waves. Radio-frequency electric currents passed through the copper coil inside the bulb create the waves. A disk of metallic tungsten at the center of the coil absorbs the waves and causes the disk to

Get the benefits of *high compression*

AUTOMOTIVE engineers have long known that the efficiency of gasoline engines increases as their compression is raised.

The compression of the present day automobile is as high as the limitations of ordinary gasoline permit. Gasoline is not a perfect fuel. It explodes too soon (*i. e.*, "knocks" and loses power) when compressed beyond certain limits.

That is why automotive research devoted many years to the development of "ETHYL" fluid, which, when mixed in very small quantities with motor gasoline, eliminates its knocking tendencies and makes it a high compression fuel. The fuel so mixed is Ethyl Gasoline.

Ethyl Gasoline has brought the benefits of high compression—greater power and flexibility, faster pick-up, reduced gear-shifting—to hundreds of thousands of motorists. This is because carbon deposits raise the compression of your engine beyond the point at which it was designed to perform efficiently with ordinary gasoline.

Try Ethyl Gasoline to-day. Enjoy a driving satisfaction and engine performance that you have never before experienced with your car. The "ETHYL" trade-mark shown above identifies the Ethyl Gasoline pump.

What high compression means to you

THE principle of high compression is readily understood. The tighter you pack the powder charge in a muzzle loading gun, the greater the force given the bullet. Similarly, the tighter gasoline vapor and air are compressed in the combustion chamber (the space between the head of the cylinder and the top of the piston) before ignition, the greater the power derived from the explosion.

Increasing compression therefore simply means decreasing the size of the combustion space, which may be accomplished mechanically or through the formation of carbon.

Higher compression means a more powerful and flexible car, less gear-shifting, faster pick-up. In short, a performance impossible with lower compression and the use of ordinary gasoline.

ETHYL GASOLINE CORPORATION, 25 BROADWAY, NEW YORK CITY

ETHYL GASOLINE

Applied Science for the Amateur

A Department Devoted To the Presentation of Useful Ideas. Material of Value To All Will Be Found Here

CONDUCTED BY A. P. PECK

A Trap for Crows

FOR trapping crows in places where they become so numerous that it is necessary to reduce their numbers, this immense cage-like structure is being used successfully. The trap is about six feet in height and of any desired size. The trap is covered with poultry wire, and after a number of crows have entered it to eat the corn sprinkled on the inside, a wire operated from a blind closes the gates. *Contributed by Allen P. Child.*

In the center of the field is one of the crow traps described here

Silver Soldering

THE proper method of soldering two pieces of silver together is admirably put forth by F. Capello in a recent issue of the *General Electric News*. We recommend this system to our readers, and reprint Mr. Capello's directions below.

"First, the surfaces to be soldered should be thoroughly cleaned by filing, sandpapering or otherwise.

"Second, the flux to be used should be borax, fused or commercial, and silver solder. The borax should be pulverized and mixed with water to make a paste of the consistency of light cream. Should the paste become hard before use, thin with water.

"Third, moisten the surfaces to be soldered with clean water and apply sufficient borax paste to cover the joint. In applying the paste, it is best to use a round steel or iron rod about one eighth inch in diameter by 10 inches long, which for convenience should be flattened at one end to spread the paste before heat is applied and pointed at one end to dip into the paste to guide the flowing silver where required.

"When ready to apply the torch, care should be exercised to heat the borax slowly, as if heated too quickly it has a tendency to spit and sputter and may burn skin or clothing. When the borax puffs up like a grain of popcorn and then begins to shrink, apply the heat gradually until using full capacity of the torch.

"When the parts are cherry red, apply silver solder to fill the joint or gap. Do not use the solder to assist the flow, as the flame may melt the silver bar, causing a bad looking joint as well as loss of silver. Use the small rod.

"Having completed the operation, dip the article into hot water to assist in removing the borax from the surface. If it is not possible to dip the article because of its size, use a sponge or piece of waste with hot water and wash the surface."

The "Florida Floater"

AN inexpensive float that will furnish many hours of fun at the bathing beach may be made by any ingenious boy or girl. The device as illustrated in these columns is made from two poles eight or nine feet long, two cross-bars, some cloth for the seat, and two automobile inner tubes capable of holding air. These are all assembled as shown. A double bladed paddle can be made from another pole and two short pieces of plank.

I designed this floater for my niece, who appears in the photograph, and after it was put to use, it was found to be capable of supporting the weight of seven adults, thus proving its safety. *Contributed by Lydia Allen DeVilbiss, M. D.*

Protecting Battery Terminals

THE following method of preventing the corrosion of storage-battery terminals will be found to be perfectly effective. After the cable has been fastened to the terminal, shape a cardboard form so that it will enclose the terminal and a small part of the cable. Pour melted paraffin into this form so that the terminal is completely covered by the wax. Allow to harden, and remove the form. Before this work is started, the terminals should be carefully scraped clean and then washed with either ammonia water or a solution of baking soda. *Contributed by A. A. Fonken.*

[The wax used for sealing storage-battery cells would probably be better for use in this work. It would not tend to soften or run in warm weather as would paraffin. *The Editor.*]

A "Mouse-Fish"

A MOUSE is one of the easiest creatures to tame, although it is true that there are very few uses for him after he is trained. However, a few years ago, some telephone workers were most grateful to the tiny rodent who helped them out of a difficulty that had tied up the job for most of two days. They were trying to run a conduit through a narrow pipe and around a bend without much success, when someone suggested rather idly that they send a mouse through with it.

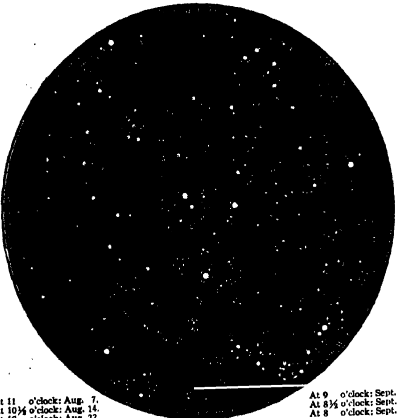
First catching a mouse, they tied a "fish" wire to his tail and fastened this in turn to a piece of metal tape. All that remained to be done was to make the mouse run through the pipe; time after time he started only to turn around and come back. Finally by blowing sulfur fumes through the open end behind him, the workman induced their little pet to run through, dragging

(*Continued on page* 178)

The "Florida Floater" is easily made from odds and ends and affords much pleasure to its user at the bathing beach

The Heavens in August

By PROF. HENRY NORRIS RUSSELL, Ph.D.



At 11 o'clock: Aug. 7.
At 10½ o'clock: Aug. 14.
At 10 o'clock: Aug. 22.

At 9 o'clock: Sept. 6.
At 8½ o'clock: Sept. 14.
At 8 o'clock: Sept. 21.

At 9½ o'clock: Aug. 29.

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on August 7, etc.

NIGHT SKY: AUGUST AND SEPTEMBER

The Planets

THIS month Mercury is a morning star and can best be seen on or about the 8th when he is in his greatest elongation, 19 degrees from the sun, rising about 3:15 A.M., standard time (all the times given here are standard time, taking no account of daylight saving time). Being north of the sun and very bright—equal to Vega—Mercury should be easy to see. Toward the end of the month he is lost to view.

Venus is still an evening star and is at her greatest brilliancy, eleven times as bright as Sirius. She remains in sight till 8:45 at the month's beginning, but at the close she sets at 6:50, and is practically lost to view. Telescopically she is a narrow crescent of large size, her diameter from horn to horn measuring from 35 to 55 minutes of arc, so that the crescent phase can easily be seen with a good binocular.

Mars is also an evening star, setting before Venus for most of the month. But later, toward its close on the 27th, the two planets are in conjunction, although by no means closely, their least distance being nearly 9 degrees.

Jupiter is in Pisces and is beginning to get into the evening sky. He rises at 9:40 P.M. on the 1st, and 7:40 on the 31st.

Saturn is in Scorpio and is in quadrature east of the sun on the 25th, on which date he is due south a little before 6:00 P.M.

Uranus is in Pisces, close to Jupiter. On the 19th the two planets are in conjunction, Uranus being only 50 minutes of arc north of Jupiter. This affords an excellent opportunity for the amateur to identify the remote planet. Although visible to the naked eye on a clear dark night when isolated, Uranus when so near Jupiter will be hopelessly invisible without a good binocular. All through the month these planets are close together in the sky; on the 1st Uranus is about 28 minutes west and 32 minutes north of Jupiter. In actual brightness, to our eyes, Uranus is inferior to Jupiter's brightest satellite, although he is really ten times the diameter of the satellite, and at the same distance he would look about 100 times as bright. But since he is more than three times as far away from the sun, and four times as far from us, he appears fainter.

Neptune is in conjunction with the sun on the 21st and is therefore invisible this month.

The moon is in her first quarter at 12:48 P.M. on August 5th; full at 11:37 P.M. on the 12th; in her last quarter at 2:54 P.M. on the 19th; and new at 1:45 A.M. on the 27th. She is nearest the earth on the 15th, and farthest off on the third, and again on the 31st. During the month she passes through conjunction with Saturn on the 7th; Uranus and Jupiter on the 15th; Mercury on the 26th; Neptune a few hours later; Venus on the 28th; and Mars the same evening, these two planets being almost in conjunction at that date, as stated above.

the wire and tape. Cheese in large quantities was set before him as a reward and he remained about the place, tame as any cat, for several days afterward, looking for more food—perhaps for another job!—*Contributed by Mrs. F. H. Waldo.*

[According to the contributor, this incident is vouched for by the telephone company's officials of Manden, North Dakota. If anyone else attempts a similar use for a mouse, it is our suggestion that a thin cord be attached first to the rodent's tail, possibly using adhesive tape as the fastening medium. This cord can later be used to pull the "fish" through. There is no doubt in our minds but that this simple system will work.—*The Editor.*]

Tagging Cables

BATTERY cables on radio sets and similar electrical installations are difficult to "trace out" when terminals happen to come loose, or are disconnected for repair purposes. To make sure that the connections are always replaced in their

Attaching tags to battery cables and the like, as shown, prevents the possibility of making wrong connections to terminals

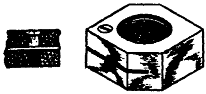
correct locations, each wire of the cable should be tagged when first put into service. If each end of each wire is tagged and noted, there will be no possibility of making wrong connections in the future. The system is illustrated in these columns.

Lock Nut

A CASTELLATED nut and cotter pin can not always be employed where it is necessary to use a lock-type nut. Numerous times the space is rather limited and the height of the nut must be taken into consideration. Again comes the time when a nut is to be inserted in a counterbored hole and tightened. Here the difficulty of inserting the cotter pin presents itself. On some type of machines, the working arms pass close to the body of the machine and here clearance must be considered. Only a flat type of nut can be used but difficulty presents itself in the locking of such a nut.

Such situations may be readily overcome by the use of a special type of lock nut which is locked in place by a flat-head machine screw inserted in one corner of the nut. To make one of these, cut down through the center of the nut with a hack saw to a depth of a little more than one half. Then drill one corner of the nut for the particular size of machine screw to be used, the size to be governed by the size of nut used. Tap the bottom half of the hole and make the upper h—

slightly larger than the threads of the machine screw. Countersink the hole at the top. After the nut has been tightened on the bolt, draw up on the machine screw with a screw driver. This will tighten the two sections of the nut against the threads of the bolt and com-



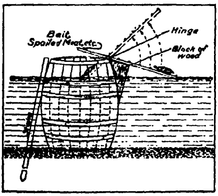
A lock nut designed by one of our readers. Tightening the machine screw draws the halves of the nut together and locks the threads, preventing the nut from turning

pletely lock the nut until the machine screw has been removed. *Contributed by Peter Hagen.*

An Efficient Turtle Trap

THE turtle is a great destroyer of fish eggs, and if you are to have a good fish pond, says the Kentucky Game and Fish Commission, according to *Field and Stream*, the turtles must be removed. Here is a handy, cheap trap that can easily be made by anyone.

The board should be attached to the top of the barrel by a free-working, ordinary strap hinge, and almost on a balance, so when the turtle climbs up to get the bait, the end over the barrel will tilt, and drop him into the empty barrel. The other end



Trapping turtles is easy with an arrangement such as that shown above. Climbing after the bait, the turtle is tipped into the barrel, from which it can be removed at leisure

will then drop back on a level with the water, ready for another victim. Cleats should be placed on the tilting board so the turtle will not slip off when climbing up.

Riveting

WE all know of the destructive force of vibration, but do we all apply this knowledge in our work? For example, when metals are riveted together, do we always make tight joints so that there will be no danger of vibration? One of the points of riveting that escapes the attention of the average amateur mechanic is that the holes for the rivets must be just large enough for the rivets to be pressed or lightly hammered into place. Then there will be no play in the finished job, and the possible effects of vibration will be eliminated.

Radio Notes

(*Continued from page* 172)

"The sub-specialization in radio engineering will deal with the theory and construction of the specialized circuits used in radio transmitting and receiving apparatus, together with a careful study of that universal device, the triode, or three-electrode tube. A great deal of emphasis should be placed on the laboratory side of the work because the field is new and rapidly changing, and only those who have had direct contact with actual equipment will be spared the continual mortification of embarrassing mistakes based upon too slavish a reliance on narrow theoretical considerations.

"There are today relatively few universities giving training in the field of radio engineering, which, perhaps, is just as well, since the absorption of trained men in the radio-engineering field (despite public interest in this field) is rather limited. It may be added that radio engineer, on graduation from the university, is only qualified to begin his career in a somewhat humble capacity, since he must get experience in the test, design and manufacturing divisions of a commercial organization of some scope before he can be depended upon to meet the requirements of this fairly difficult profession. However, it is a most interesting field and the workers in it feel that they are in the van of progress."

A Good Record

BLOOMSBURG, Pennsylvania, must be a good place for ideal radio reception according to a record established by G. E. Elwell, Jr., of that town. He picked up station KFI, Los Angeles, on 200 consecutive nights. The log which he forwarded to the station for verification checked exactly with the programs as broadcast, according to officials at the station. Bloomsburg is 2,400 miles from Los Angeles. Mr. Elwell's record of reception is 496 stations. The total distance from his home to the broadcasters he has heard is estimated at 321,000 miles.

No Fear of Saturation

A SURVEY based upon questionnaires sent to 25,000 substantial families in 25 cities by the New York University Bureau of Business Research, revealed that only 36 percent of the well-to-do families, 97 percent of whom own automobiles, have radio receivers. It is estimated that 64 percent of these families are prospects for high-priced receivers.

The bureau's report says, "It is quite evident that the well-to-do urban dwellers in the United States are far from being 'sold' on radio apparatus."

2XAF Schedule

NUMEROUS requests from foreign listeners, particularly radio fans in the tropics and south of the equator, have led to the expansion of the schedule of 2XAF, the 32.77-meter transmitter of the General Electric Company at Schenectady, New York. 2XAF broadcasts the programs of WGY on the following schedule: Tuesday, 6 to 11.30 P.M., Eastern Standard Time: Thursday, 6 to 12.30 P.M.; Saturday, 6.30 to 12.30 P.M.

Lindbergh's Transatlantic Flight

(*Continued from page 169*)

but trusted, like many pilots, to a certain "feel" of these various instruments.

Lessons of the Flight

While Lindbergh was entirely successful by a wonderful combination of skill, pluck and youth, this does not indicate that the day of transatlantic commercial air services has already arrived; still less that there is an immediate possibility of an early New York to Paris air service.

The flight from San Diego to New York and from New York to Paris, demonstrated the most wonderful reliability of the modern aero engine, particularly in its air-cooled form. Considering that the Wright engine stood up for 21 hours and 45 minutes across the continent, and for over 33 hours across the ocean, in every sort of weather and temperature conditions, while operating at close to its rated power throughout, its reliability is nothing short of miraculous. Nevertheless, a multiple-engined power plant will most certainly have to be employed for transatlantic work. Three engines at least, perhaps five or even seven, will have to be employed.

Lindbergh's plane, heavily loaded with gasoline, just barely managed to get away from Mineola. It carried no relief for the pilot, no special navigator, and absolutely no pay load. Even Byrd's plane, though it had a larger crew, had nothing to spare for commercial pay load. It seems quite clear that if a commercial air line is to be established between New York and London or Paris, there must be intervening stops. Stops at Newfoundland and Ireland for refuelling would lengthen the time of the voyage by an unimportant amount, but they would cut down by half the amount of gasoline to be carried, and allow the carrying of passengers, mail and freight.

There are many present-day ships capable of such a non-stop flight from Newfoundland to Ireland. It cannot, however, be said definitely that they are already so efficient as to make such a service profitable. Nor are the seaplanes that have already been built, so large and so seaworthy as to be entirely immune from the results of a forced landing. If larger seaplanes are built, they become less, rather than more efficient than smaller craft. The structural weight of the larger craft begins to bear a prohibitive ratio to the gross weight of the plane, and the aerodynamic efficiency diminishes likewise. Designers must start anew, and think of machines in which practically nothing remains but a huge wing, with engines distributed along the span so as to reduce stresses and structural weight. Or they may turn in the direction of triplanes. Or even perhaps in the direction of tandem planes, where the wings are distributed along the length of a huge hull and concentrated loads are thus lessened. However, tandem planes will probably wait till monoplane possibilities are entirely exhausted.

It may be said that, since Lindbergh achieved successful navigation by using only part of the methods now available, the problem of successful navigation is almost completely solved. The only possible danger lies in fog. In fog, both sighting of the earth's surface and sighting of the sun becomes impossible. To meet this difficulty airplanes will have to be equipped with powerful radio sets and be

able to get their bearings from shore stations and from surface vessels. There should be no difficulty in this. It is merely a matter of applying existing methods.

There must also be better meteorological service. For summer months, our knowledge of North Atlantic meteorology is perhaps already adequate. But for all-year-round flying, such service must be vastly improved. When Lindbergh set off he had favorable reports. But the weather men did not inform him of the sleet-filled clouds off Newfoundland which proved his greatest peril. The Weather Bureau can at present secure better information by special arrangements with radio companies and surface vessels. A complete system must be organized for such collection of data.

The suggestion has also been frequently made that floating stations be provided for emergency and refuelling purposes.

On the whole Lindbergh's flight will give a tremendous impetus to commercial attempts to conquer the Atlantic. Granted multi-engined power plants, huge seaplanes in which structural problems have been so carefully studied that size means no decrease in efficiency, systematic weather service, and radio aids to the navigator, we see no reason why, in a very few years, a transatlantic mail or passenger service may not be as feasible as one across the continent is now.

Air-cooled Engines for Aircraft

(*Continued from page* 151)

themselves to be at no great disadvantage.

The theoretical advantages of the air-cooled, vee engine over the radial are being confirmed by experimental results. In return for a slightly higher (at the moment) weight-horsepower ratio, the air-cooled, vee engine offers reduced head area, increased smoothness of operation, higher maximum crankshaft speeds, more readily adjustable degree of cooling, and simplified installation problems. These advantages are increasingly important in the larger sizes. We shall probably discover before very long that some compromise between the two is more desirable than either the vee or radial, but at present the radial, air-cooled engine appears to possess the majority of the advantages in small powers, the vee in the intermediate range and the X in the high-power range (1000 horsepower and above).

This vindication of the air-cooled, vee engine has led to the development by aircraft engine manufacturers of at least two air-cooled, vee engines now in the design stage. The success of the air-cooled Liberty engine has also led to the development by the Engineering Division of a 24-cylinder X type engine of 4520 cubic inches displacement, rated conservatively at 1200 horsepower at 1800 revolutions per minute. Single-cylinder tests of the X engine cylinder have produced highly satisfactory results which indicate that the completed engine can be expected to develop its rated power at 1600 revolutions per minute or even below that figure.

There are also in development two rather unconventional types of air-cooled radial engines, the Cam engine now being developed by the Fairchild Caminez Engine Corporation and the Kinney radial engine under development for the Navy. Both are, on the whole, very promising types.

but still largely in advanced experimental status. The Cam engine is a 150-horsepower radial in which a double-lobe cam replaces the crankshaft. The cylinders are of the screwed and shrunk aluminum-head type, employing the Engineering Division type M cylinder head on a special barrel. The Kinney radial was developed at the request of the Navy for training purposes. It was originally designed as a sleeve-valve, five cylinder, radial engine. The design was modified after preliminary tests and now incorporates a bolted-on head cylinder with an improved hydraulic (oil operated) valve gear.

The present status of the air-cooled engine in this country can be summed up rather briefly. There are two air-cooled radial engines in production status, the 400-horsepower Pratt-Whitney Wasp and the 200-horsepower Wright Whirlwind. There are two more air-cooled radial engines of approximately 425 horsepower in service test status—the Wright P series and the Curtiss R-1454. There are in promising experimental status at least five more radial engines, ranging in power from 60 to 600 horsepower. There is in service test status also one two-cylinder opposed air-cooled engine, the Wright Morehouse M-80. In the air-cooled vee and X types there are in service test the air-cooled Liberty of 430 horsepower, and in experimental status the Engineering Division 1200-horsepower X engine and at least two air-cooled vee engines capable of developing approximately 500 horsepower.

There seems now to be no unwillingness on the part of aircraft-engine manufacturers to engage in air-cooled engine research and design. Whereas several years ago it was difficult enough to buy experimental work on air-cooled engines, today we can easily name at least six projects by nearly as many companies, which have been undertaken and probably will be carried completely through the experimental stages without support or assurance of support by aircraft engine buyers. The air-cooled engine is certainly being given an opportunity to prove itself, and present-day results pear to vindicate the work involved.

Byrd's Preparations

A transatlantic flight which will differ in its significant aspects from those successful flights of Lindbergh and Chamberlin is, at the time of writing, marking time and awaiting the arrival of propitious weather. This flight is under the direction of Commander Richard E. Byrd and is sponsored by the America Trans-oceanic Company. The plane is a huge three-engined Fokker, using air-cooled Wright "Whirlwind" engines and carrying 1300 gallons of gasoline. It will transport four men and the first official transatlantic air mail, consisting of 200 letters. Radio equipment, life rafts, medical supplies, et cetera are to be carried, and these facts will show, if the flight is successful, one more great step toward transatlantic aerial freight service. When the flight has been completed, the SCIENTIFIC AMERICAN will carry a complete report of it and of the plane that accomplished the feat.

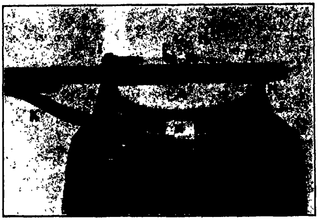
—*The Editor.*

Automatic Machine Makes Telescope Mirrors

IN the June issue, page 424, we published a letter describing a telescope made o automatic grinding and polishing ıine invented by an amateur of our

"It is probably unsportsmanlike for the amateur telescope maker t- consider anything in the way of

mirror. There gades, and I am



The grinding and polishing machine at work. Power is transmitted through the wooden arm which extends to the left, out of the picture. It may be given a slow reciprocating motion by a crank or any mechanism devised by the amateur. In operation, the upper disk A turns clockwise; the lower disk B, counterclockwise

acquaintance, who signed himself "A Wellesley Enthusiast." We promised our readers to forward letters to this gentleman, but so very many inquiries were received that he was forced to defer the requests for individual descriptions and send us for publication a single description that would suffice for all. Machines, as such, for doing this sort of work are not new; but this one is wholly original. If you make one of these machines the telescope editor, and through him the inventor, would greatly appreciate detailed word about its performance. The inventor describes the device as follows:

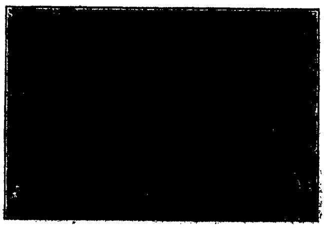
"The pictures show a simple form of machine which almost anyone could make in a day or two from material taken from the scrap heap. One of them shows the machine ready for operation, and the other one shows the separate parts.

"What seems to be a novel feature in this machine is the immersion of the rubbing surfaces in the grit or rouge mixtures, thus eliminating the necessity of constant attention.

"Most of the sheet metal work is made of number 22 B. and S. gage galvanized iron.

"The lettered parts are as follows: *A*: Disk with 83 teeth cut in the

Parts of the ______ shown in the illustration above. In conversation with the telescope editor, the inventor emphasized strongly the necessity of keeping the rouge evenly distributed in the liquid. Unless full attention is given to this point, trouble will be had. If you duplicate this machine, please advise us how it works



edge to form a ratchet wheel. On the lower side is soldered a dust rim and six clips to grip the mirror holder *C*.

B: Similar to *C* except that it has 60 teeth and the six clips are on the upper side to hold the pan *D*. The lower side has rigidly fastened to it a spindle for insertion in the t[illegible]

C: Cup-s[illegible]
rigid spi[illegible] passes through disk *A* and connecting rod *F*. The rim on the inside has three pieces of rubber, spaced at regular intervals and fastened with shellac. Over the mirror is placed a disk of rubber (old inner tube) to serve as a cushion.

D: Recessed tray for holding the lap and grinding or polishing mixture.

E: Wooden base with central hardwood turntable.

F: Connecting rod for transmitting a reciprocating motion. (60 strokes a minute is a satisfactory speed.)

G: Wooden block to be fastened to the face plate of a lathe or other rotating device to impart motion.

H: Adjustable guide.

I: Adjustable pawl for turning disk *A*.

J: Pawl to prevent backward motion of disk *B*.

K: Pawl for turning disk *B*.

L: Guide for controlling pawl *K*.

M: Pawl to prevent backward motion of disk *A*.

N: Stirring device of hard wood, mounted on a flexible and readily detachable arm.

"An inspection of the pictures will show that the machine is capable of performing all the ordinary hand strokes of grinding and polishing. A practically straight stroke can be imparted by substituting a long arm in place of the short one *H*.

"Pressure is obtained by clamping weights on connecting rod *F*. Fifteen pounds is sufficient up to the finest polishing, when no weight is desirable.

"The barrel on which the machine is mounted serves as an element of safety in case there is a tendency to grip; in this event it will tip. Gripping can be eliminated during the grinding by the use of a grooved lead lap in place of glass.

"There is an advantage in adding to the grinding mixture, something to increase the density as well as the gravity of the liquid, such as sugar or other inert substance, and thus retard the precipitation of the grits during the grinding process. The stirring device alone is not sufficient for the most satisfactory results.

"The laps are raised and lowered in the recessed tray *D* by means of rubber disks, and a thick rubber band is placed around the edge of each lap.

"One six-inch glass mirror was ground, polished and figured on the machine without any hand rubbing. A six-inch quartz mirror was made on it up to a polished sphere, and the final figuring was done by hand.

"The device is most satisfactory during the fine grinding and polishing. If a mirror has been overcorrected and is in the form of a hyperboloid or some other monstrosity, it is only necessary to put in a suitably trimmed lap and let the machine run by itself until the desired results are attained."

A Wellesley Enthusiast.

The Tree That Swallowed a Tree

THE letter quoted below explains itself. No finer source of quotation than John Muir, former guardian of the

nation's forests, could be chosen. John Muir is dead, but his books, including the one mentioned below, will ring down through the centuries when the white man has made of the Sierras a white man's shambles.

Editor, Scientific American:

In your September number, page 233, there is a note about a "tree that swallowed a tree." I wondered when reading it if the following, from John Muir's "My First Summer in the Sierra" would not explain it.

"Have been sketching a silver fir that stands on a granite ridge a few hundred yards to eastward of camp, a fine tree with a particular snow-storm story to tell. It is about 100 feet high, growing on bare rock, thrusting its roots into a weathered joint less than an inch wide, and bulging out to form a base to bear its weight. The storm came from the north while it was young and broke it down nearly to the ground, as is shown by the old, dead, weather-beaten top leaning out from the living trunk built up from a new shoot below the break. The annual rings of the trunk that have overgrown the dead sappling tell the year of the storm. Wonderful that a side branch forming a portion of one of the level collars that encircle the trunk of this species (*Abies magnifica*) should bend upward, grow erect, and take the place of the lost axis to fo..."

Yours very truly,
Isabel P. Jaggar,
Volcano Ho...

Worms as Artists

ONE of our readers, Mr. E. V. Morse, of Chesterland, Ohio, in the course of his wanderings through the woods has come across an interesting example

Certain types of wood - boring worms leave fancy designs. This is an excellent example of their work

of natural artistry. This is in the form of a section of tree trunk which has been "carved" in a unique manner by worms. Mr. Morse very kindly sent us this bit of wood, and a photograph of it is reproduced in these columns.

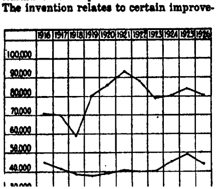
Commercial Property News

A Department of Facts and Notes of Interest to Patentees and Owners of Trademark Rights

CONDUCTED BY MILTON WRIGHT

Delays Are Fatal

THE disastrous results of delay in asserting claims in an interference action in the Patent Office are well illustrated by the recent decision of the Court of Appeals of the District of Columbia in refusing to permit Joseph J. O'Brien the right to appear as a claimant for a patent on an invention. The invention relates to certain improve-



An anomaly in Patent Office statistics. The top line shows the number of patents applied for year by year; the bottom line the number of patents issued. You would think that the two lines would fluctuate in harmony—that the number of patents would increase or decrease in direct ratio with the number of applications. As a matter of fact, they do nothing of the sort. Patent Office officials have one explanation to offer and we have another. How do you figure it out?

ments in forms for structures for plastic material and methods of applying continuous conduits. O'Brien filed his application in 1918; George A. Bonelli filed an application on a like invention in 1919. In 1922, no interference having been declared between the two applications, a patent was granted to Bonelli.

In 1924, notwithstanding that more than two years had elapsed after the date of Bonelli's patent, the Examiner instituted an interference proceeding between the parties, O'Brien copying Bonelli's claim.

In 1925, priority was awarded to O'Brien, but afterwards the Examiner vacated this award upon the ground that O'Brien had no right to maintain the interference for the reason that more than two years had elapsed after the granting of Bonelli's patent. The appeal went up to the Court of Appeals of the District of Columbia, where the court held:

"The decisive question is whether O'Brien was entitled to be heard in the interference proceeding in view of the fact that more than two years had passed after the granting of Bonelli's patent, without the declaration of such an interference.

"This question is answered in the negative by Sundstand v. Gubelmann, 55 App. D. C. 200, wherein this court held that in the absence of special circumstance justifying the delay in copying claims from an issued patent, the two years' limitation applies, and there is no basis for the declaration of an interference."

The New Copyright Law

AS a result of legislation enacted by the last Congress, it is now possible to obtain copyright protection for published works produced by mimeograph, photo-lithograph, photo-engraving, photostat or similar process. Heretofore the specific requirement of the copyright law has been that a book or periodical must be "printed from type set within the limits of the United States . . . or from plates made within the limits of the United States from type set therein."

Explaining the new law, the Registrar of Copyrights, Thorvald Salberg, makes the following statement:

"The difficult situation brought about by the World War in regard to printing made it necessary or convenient in substitution for printing from type set, to resort to other methods for the production of many classes of books and periodicals. The exact number of such works is not known, but it is reasonably safe to believe that they numbered many thousands.

"University professors and other teachers in the higher schools and similar institutions have suffered seriously by this loss of copyright for their books because they were not printed from type set.

"It is certainly a reasonable proposition that the copyright granted to authors by Congress to protect their writings, as authorized by the Constitution, should not be lost to certain authors by reason of the requirements of our present copyright laws as to methods of production. This amendatory act allows the author, who alone knows all the facts in relation to the publication and distribution of his book, to select his own method of production, and still be sure of his adequate protection from the time his work is actually published in the United States by any process of production.

"The enactment of this measure of relief from the restrictive type-setting requirements, in behalf of university professors and others, will also prove a considerable relief to the copyright office.

"Thus the law as amended permits the registration of copyright for books prepared in mimeograph, photo-engrav-

Patents Recently Issued

Classified Advertising

Advertisements in this section listed under proper classifications, rate 25c per word each insertion; minimum number of words per insertion 24, maximum 60. Payments must accompany each insertion.

Official copies of any patents listed in this section at 15c each; state patent number to insure receipt of desired patent copy.

Pertaining to Aeronautics

BALLOON CAPABLE OF BEING EMPLOYED AS A CAPTIVE OBSERVATION BALLOON AND AS A DIRIGIBLE—Comprising a gas bag, in combination with two interchangeable cars, viz., a wicker observation car, and a car provided with propelling means, both provided with suitable suspensions. Patent 1629374. L. Avorio, c/o L. Laboccetta, Via Due Marcelli 31, Rome, Italy.

WING CONSTRUCTION FOR AIRPLANES—Which is adjustably vibratory from the leading edge to the trailing edge for the purpose of producing a definite pulling action. Patent 1628940. J. Wenger, 721 Laurel St., Highland, Ill.

AIRPLANE WING CONSTRUCTION—Which permits of flying, taking off, climbing or alighting at slower speeds and with lesser angle than is usual. Patent 1630938. J. E. Griffin, Box 67-A, Route A, Savannah, Ga.

Chemical Processes

PROCESS AND APPARATUS FOR RECOVERING SILVER FROM PHOTOGRAPHER'S SPENT HYPO-SULPHITE SOLUTION—Whereby the exhausted hypo-sulphite of soda is placed in a special equipment in which are disposed positive and electric plates forming electrolyte, whereby the silver will be deposited. Patent 1629-212. E. K. Griffen, Salida, Colo.

Electrical Devices

CAP OR SOCKET FOR INCANDESCENT ELECTRIC LAMPS AND THE LIKE—By means of which soldering between the parts may be carried on, without danger of the soldering iron or blow-pipe approaching too near the bulb. Patent 1630126. A. J. B. Marsat, c/o C. Chassevent, 11 Boulevard de Magenta, Paris, France.

ELECTRICAL-TUBE-CONNECTOR TWISTING DEVICE—Especially adapted for splicing two electrical conductors together, by a ratchet mechanism, where little clearance room can be had for performing the operation. Patent 1629800. W. J. Leach, 715 Pine St., Burlington, Wis.

LOGGING DEVICE FOR RADIO TUNING INSTRUMENTS—Adapted for disposition upon radio couplers employed in the ordinary radio circuit for turning the shaft to tune the instrument in selecting certain stations. Patent 1630802. E. H. Larson, 5897 Byron St., Chicago, Ill.

ing, or similar processes if duly published by offering such copies publicly for sale or for other public distribution. The office requires an affidavit of actual publication. If not publicly offered for sale, the copies must be published by public distribution without specific limitation on those to whom it might be circulated.

A Good Word For Trusts

TO the Planning Committee of the International Economic Conference at Geneva, Paul de Rousiers, professor at the Ecole des Sciences, Paris, has made a report recommending statutory regulation for trusts and combines. The report traces the organization of cartels in Germany, trusts in the United States, amalgamations in England and associations and agreements in France and other countries. It outlines the organization of international trusts and agreements and in this connection specifically discusses the United States Steel Corporation, the Standard Oil Company, the German dye trust and the potash and steel consortiums.

"The charge most often advanced against agreements is that they tend to put up selling prices," says Prof. de Rousiers. "This charge applies chiefly to the early days of the cartels; it is based upon the fact that at times of crises, when prices are falling, agreements are instrumental in keeping them above the level to which they would otherwise drop. All the inquiries carried out in Germany, Great Britain and the United States prove, however, that when there is an upward tendency, the cartels exercise a contrary influence and keep prices below the level they would otherwise attain.

"In other words, they have a stabilizing and regularising action. Thanks to them, price curves less frequently assume those acute angles which confound all estimates, discourage initiative and give industry the appearance of a disastrous gamble. They are thus of benefit not only to the producers but also to their customers.

"Agreements offer the clientele a further very important advantage, namely, that of paying prices which are not only less variable than formerly but are always uniform for everyone alike, at any given moment. This benefit is of special value to small purchasers; it ensures them real protection."

Grade Marks And Trade Marks

CAN a grade mark be a trademark? The question came up recently in a Patent Office opposition proceeding between Oakford and Fahnestock versus King Midas Mill Company against the registration by the King Midas Company of "White Oak" as a trademark for flour. In dismissing the opposition and holding the trademark entitled to registration, Assistant Patent Commissioner M. J. Moore says:

"There is certainly nothing about said mark to suggest quality or grade. The mark is clearly arbitrary and fanciful when appropriated to flour, and is used primarily to distinguish the applicant's goods from like goods of other traders. The fact, assuming it to be a fact, that the applicant has other trademarks appropriated to the same goods, is immaterial. As was stated by Judge Learned Hand:

" 'Now, in principle there is no possible ground for refusing to recognize any number of trademarks which are really such.'

"It is also well settled that there may be different trademarks for different grades or qualities of the same product, provided they are so used to distinctly indicate origin or ownership as well as grade."

Each Sock Stands Alone

IS a pair of socks singular or plural? Authorities on grammar may think a pair of socks is a unit and takes a singular verb. Singularly enough, however, the United States Customs Court says a pair of socks is plural and takes a plural import marking.

The Irish Textile Company found this out recently when it imported woolen hosiery into the country. The proper legal marking was placed on one sock of each pair. It was not enough, the court held, whereupon it imposed an additional penalty of 10 percent upon each unmarked sock. For tariff purposes each sock is regarded as a separate article of commerce and therefore each one must be marked.

The Katz Underwear

THE Katz Underwear Company is denied the privilege of registering a picture of a cat's head as a trademark, because of the likelihood of confusion with the cat's-head trademark registered by the Corticelli Silk Co. This decision is made by the Patent Commissioner in spite of the fact that for years the Katz Company used as its trademark a picture of three cats. The Corticelli uses the cat's head for spool silk, but also has used it on stamped linens, braids, dress silks, underwear and hosiery, although its use on some of these goods has been discontinued. The Katz Company desired to register a similar mark for underwear.

"The issue here," says Assistant Commissioner Kinnan, "is the old one so often decided by this court: would appellant's use of the mark on underwear lead the ordinary purchaser to believe that he was buying the goods of appellee? We think the word 'class,' as used in the statute, means broadly a genus including as species any goods upon which the use of the same mark, when the goods are exposed side by side, would tend to mislead the purchasing public. We have no difficulty in applying this rule to knitted and textile undershirts, drawers, and union suits on the one hand, and men's, women's, and children's stockings on the other.

"The examiner points out that each party has used his mark for several years, and that opposer has not submitted proofs of actual confusion in trade. This act is not deemed controlling. The opposer, as is well settled, is not required to prove actual confusion; the establishing of the likelihood of confusion is sufficient. Opposer was long prior in the field with the cat's-head mark, even using it on underwear before and at the time applicant adopted the cat's-head mark."

Of Interest to Farmers

TOBACCO HARVESTER—By the use of which it is possible to transfer the leaves to drying sticks almost immediately upon harvesting them, without bruising by excessive handling. Patent 1629442. J. C. Trulove, Shoals, N. C.

Of General Interest

COMBINATION DRAIN BOARD AND COVER—Formed from one piece of metal which seats down in the body of a combination sink and laundry tray structure preventing the spilling of water. Patent 1628746. J. W. Russel, 522 Chestnut St., Columbia, Pa.

FACIAL-WRINKLE-REMOVING DEVICE—Readily applied to any portion of the face, for exerting the proper directional pull in the endeavor to remove wrinkles, without undue discomfort. Patent 1629460. H. A. Skinner, 44 Pearl St., New York, N. Y.

HOSE FASTENER—Particularly intended for bathroom attachments such as showers, the attachment having means for tightening the grip on the faucet as the water pressure increases. Patent 1629431. B. W. Bennett, 1 So. Clinton Ave., Bayshore, N. Y.

METHOD OF PRODUCING COMPOSITE MOVING-PICTURE FILMS—For so-called freak pictures, by providing a plurality of identical positive film strips and super-imposing them to register when viewed through frames. Patent 1627976. A. V. Knechtel, 1179 North Kenmore, Los Angeles, Calif.

PIPE-SEALING DEVICE—Which will cause a leak to be properly sealed without requiring the flow of liquid to be cut off during the operation. Patent 1627995. W. J. Pendry, Box 818, Martinez, Calif.

SAFETY RAZOR—In which a special holder greatly facilitates the manipulation insuring the proper relation of the cutting edge during shaving, and precludes accidental displacement of the blade. Patent 1629416. J. and M. Roman, c/o Max Roman, 267 Clifton Place, Brooklyn, N. Y.

WALL CONSTRUCTION—Wherein a special interlocking pre-cast block is used and locked in wall formation by the pouring of concrete between the assembled blocks. Patent 1627986. J. McKenzie, 11 North St., Whangarei, Auchland, New Zealand.

COMBINATION CANDY BOX AND TOY HOUSE—Which when opened can be easily assembled to form a toy house, even when the candy is still in the box. Patent 1630117. D. C. Faulkner, 461 8th Ave., New York, N. Y.

CARPET SPOOL—Wherein a journal is provided with means for efficiently holding the same in place, and a support arranged to carry a removable head. Patent 1630155. W. H. Wilson, c/o Vermont Spool and Bobbin Co., Burlington, Vt.

FINGER NAIL TRIMMER—Including a handle having at one end a nail cleaner and at its other end a nail trimmer, both protected by threaded caps. Patent 1629967. R. K. Rex, 2224 Overlook Road, Cleveland, Ohio.

BRIDGE APPROACH—In the form of a spiral ramp of double or single character associated with the floors of a building, which may be additionally employed for storage purposes. Patent 1629787. A. S. Hackett, 515 Whitney Central Bldg., New Orleans, La.

CARD RACK—Which functions to support a plurality of playing cards in substantially upright position, so as to be clearly visible and readily insertable or removable. Patent 1629070. H. T. Cox, 5676 York Blvd., Los Angeles, Calif.

CEMENTING HEAD—Of simple and durable construction, having locking means by which the head can be quickly attached to or detached from an oil well casing. Patent 1629022. H. A. and C. F. Davis, c/o H. A. Davis, Box 188, R. D. 1, Redwood, Calif.

DISPLAY DEVICE—In the nature of an emblem, which is attractive and ornamental in appearance, reversible, and adapted to carry diversified subject-matter on its two faces. Patent 1630917. H. D. Andrews, 43 Glencoe Place, Cincinnati, Ohio.

MILK-BOTTLE HOLDER—Having a latch which automatically secures the jaws around the bottle neck when the latter is inserted, the bottle will not drop when bolt is unlocked. Patent 1630409. T. C. Rouse, 1322 15th St., N. W., Washington, D. C.

SPRAY NOZZLE—Which will thoroughly and evenly distribute viscous liquid, such as oil or tar, to a road way, without choking or clogging. Patent 1630974. O. W. Shelor, and E. G. Butts, c/o Klime & Klime, Roanoke Ry. & Electric Mfg. Co., Salem, Va.

ANIMAL TRAP—For small animals such as mice or rats, adapted to be actuated by pressure applied at any point of a relatively great area. Patent 1630969. J. E. Ruby, Waynoka, Okla.

VENTILATOR—For the roof of a building, giving maximum ventilation and minimum danger of freezing the mechanism while reducing the power required in operation. Patent 1630978. J. Sobel, 214 E. 127th St., New York, N. Y.

CONFECTION PACKAGE—So constructed as to form a strong compact box for the sale of confections, including a display tray for exposing the goods without necessitating unpacking. Patent 1630984. A. Sweet, c/o Sweet Candy Co., Salt Lake City, Utah.

ANIMAL TRAP—In which nothing projects above the jaws in set position, which eliminates the necessty for a trigger or other form of trip member and will not destroy fur. Patent 1630607. W. Catlin, Rockville, Ind.

JAR CLOSURE—Including a screw cap and a closure cap which can be readily operated to hermetically seal the contents and allow of ready opening. Patent 1629639. J. O. Rollins, 1435 Federal Ave., Sawtelle, Calif.

Hardware and Tools

SPIRIT LEVEL—Which is provided with adjusting means, and embodies a level equipped with two level glasses at right angles to each other. Patent 1630122. V. E. Ivarson, Box 516, New Rochelle, N. Y.

SASH FASTENER—Acting automatically to hold the sashes against vertical movement in their slideways, the latching means being operable only from the inside of the window. Patent 1630153. J. T. Williams, Box 430, Arcade Sta., Los Angeles, Calif.

MARKER BLOCK—Particularly useful to carpenters in marking off spaces on the edges of doors which are to be mortised for the reception of hinges. Patent 1629053. C. C. Schrader, Box 86, Hughson, Calif.

GUTTER HANGER—For supporting gutters adjacent the edges of roofs, which permits the use of narrow bridge stock without detracting from strength, and eliminates riveting. Patent 1630961. C. A. Meunier, 315 Memoria St., Great Neck, L. I., N. Y.

Heating and Lighting

DRYING APPARATUS—Which affords facilities for the utilization of heat from any ordinary supply, to effect practically a complete drying of cloth, textiles and the like. Patent 1630652. M. E. Bussler, 521 St. Philip St., New Orleans, La.

Machines and Mechanical Devices

ATTACHING MEANS FOR MULTIGRAPH SIGNATURE PLATES—For attaching the signature bearing element to the platen roll of a multigraphing machine and holding the same in perfect contact. Patent 1629376. H. T. Buck, c/o T. S. Buck Mfg. Co., 87 Duane St., New York, N. Y.

BOAT-LAUNCHING DEVICE—Whereby the swinging of the boat outboard and the lowering into the water can be controlled by one man from the boat. Patent 1629419. H. L. Sorensen, 877 59th St., Brooklyn, N. Y.

COIN-CONTROLLED LOCK—Consisting of a number of co-acting parts for permitting the key to lock the door only after a coin has been inserted in the lock. Patent 1628711. W. J. Dobkin, 3210 Arthington St., Chicago, Ill.

REFRIGERATING APPARATUS—Requiring a relatively small space, in which compressed air is employed as the refrigerating medium and the moisture eliminated to insure proper operation of the machine. Patent 1628820. C. R. Bushnell, Lake Hughes, Los Angeles, Calif.

SHOE-RAISING-PLATFORM DEVICE—In which a lazy tongue structure is used in elevating a platform, and when actuated by the foot the effective height of the operator is varied. Patent 1630191. C. Liberman, 1732 Madison Ave., New York, N. Y.

MOP-ASSEMBLING APPARATUS—Wherein an internally groved ring is employed over which the strands are run, and in said ring binding wires are located for securing the inner runs of the yarn. Patent 1630187. M. Kenner, 3304 Fig St., New Orleans, La.

OVERHEAD CONVEYER—For releasably maintaining an object, such as a log, that is to be carried a given distance, below the carrier, and operate from the ground. Patent 1630959. R. A. McCourry, Knappa, Oregon.

SCRAPER SHOE—For prolonging the life of an ordinary scraper bucket; may be not only applied to old shoe supports, but to broken ones also. Patent 1629785. C. E. Gilbert, c/o Gilbert Mfg. Co., Stillwater, Minn.

SPEED INDICATOR—In which a steel ball revolving in a channel drops in certain positions at low speed, creating a sound, but will not drop at high speed. Patent 1630963. F. Mortensen, c/o Maskinach Brolyggrads Aktiebolaget, Helsingfords, Finland.

Prime Movers and Their Accessories

FUEL MIXER—Including a fan disposed across the path of the moving fuel for churning the combustible mixture into fine mist readily intermingled with the incoming air. Patent 1630161. H. Bornheim, 15 Berwick St., Everett, Mass.

Railways and Their Accessories

RAIL OBSTACLE—Which comprises a trip member, and means for the attachment of the same to a track element, to prevent unintentional movement of a carriage or train. Patent 1628552. J. B. O'Connor, 163 Eastern Parkway, Brooklyn, N. Y.

RAIL-CAR TRANSFER—A wheeled frame with slidable car rails mounted thereon for relative longitudinal movement, for use in connection with cars that are manually operated. Patent 1629805. J. F. McCarroll, c/o Standard Machine Co., Baton Rouge, La.

Pertaining to Recreation

GAME APPARATUS— In which a spinning top, upon an eccentrically rotatable table is shifted by the action of the table into any one of a series of pockets. Patent 1629383. S. Hisanesuke, c/o Mrs. A. Morse, East Shore Road, Great Neck, L. I., N. Y.

DIVIDER BOARD FOR BOWLING ALLEYS—Which is practically indestructible, having striking plates of soft, tough material, not liable to sliver, and extending the entire impact area of the board. Patent 1628344. C. B. Houser, 542 No. 23rd St., East St. Louis, Ill.

Pertaining to Vehicles

LUBRICATING SYSTEM.—Which is in continuous operation while the vehicle is traveling, forcing a lubricant in minute quantities into various bearings for shackles, springs, etc. Patent 1628240. C. C. Goodrich, 639 Turk St., San Francisco, Calif.

AUTOMOBILE LOCK.—For the transmission of automobiles, adapted to engage keepers on the shifter rods for locking the rods against movement. Patent 1625249. M. Farah, 104 So. Leon St., El Paso, Tex.

SHOCK ABSORBER.—Of the liquid controlled type, having a single compartment and means for controlling the parts therein, is accessible by the removal of a single screw. Patent 1624265. H. H. Logan, 6107 Newburg, Norwood Park, Chicago, Ill.

CABLE BRAKE.—Comprising a brake drum, a cable wrapped more than once around the drum and a retractive spring for each end of the cable. Patent 1622785. W. F. Hollingsworth, 104 7th St., San Francisco, Calif.

PARKING DEVICE FOR MOTOR VEHICLES.—For the expeditious parking of a car in relatively short spaces such as are frequently found between cars along-side street curbings. Patent 1622802. J. Myers, Oroville, Calif.

REFLECTOR-JEWEL MOUNTING.—Such as are used at the rear of bicycles, automobiles, or other vehicles, which may be mounted without drilling a hole in the fender or mudguard. Patent 1624300. J. E. Wood, 1622 So. Wabash Ave., Chicago, Ill.

MOTOR-VEHICLE HEATER.—Of the "exhaust heater" type, arranged in the floor of a tonneau in such manner that dirt will not collect and give off offensive odors. Patent 1623879. E. W. Leahy, c/o Albrass Co., Coxsackie, N. Y.

AUTOMOBILE BRAKE AND JACK.—Which will not only brake a vehicle, but will also prevent skidding, and may be employed as a jack. Patent 1625226. C. Simmons, 437 So. Center St., Reno, Nev.

TIRE SPREADER.—Which may be conveniently used with all sizes of tires for opening up the tire throughout its entire length to permit inspection of the shoe. Patent 1626460. V. R. Goeller, c/o Mountain Lakes Service Station, Mountain Lakes, N. J.

CIRCUIT-CONTROLLING APPARATUS.—Adapted for use in controlling the bright and dim lamps of head lights, and maintaining control of the steering wheel during such operation. Patent 1625832. M. A. Stein, c/o Mays & Rouse, Hoperville, Va.

RETRACTABLE VEHICLE RUNNER.—A sled runner attachment for wheeled vehicles, such as automobiles, aeroplanes, and the like, which may be quickly removed to an inactive position above the wheels. Patent 1627151. D. De Wald, 1613 Mt. Vernon Ave., Orlando, Fla.

Designs

DESIGN FOR A SHOE—Patent 72685. Maude Siegel, c/o Franklin Simon & Co., 38th St. & 5th Ave., New York, N. Y.

DESIGN FOR A SHOE—Patent 72731. Maude Seigel, c/o Franklin Simon & Co., 38th St. & 5th Ave., New York, N. Y.

DESIGN FOR A COMBINED MATCH HOLDER AND CIGARETTE CONTAINER—Patent 72745. W. G. Wolford, 425 Cecilia Ave., Cliffside, N. J.

DESIGN FOR A COMBINATION BATHROOM FIXTURE—Patent 72691. J. H. Walker, 259 Plane St., Newark, N. J.

INDEX TO ADVERTISERS

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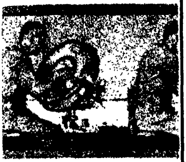

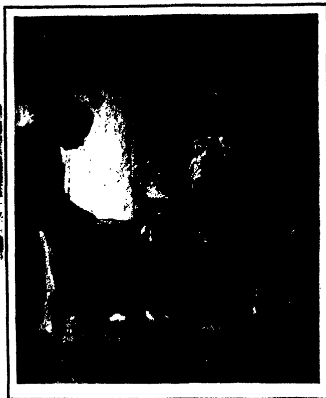

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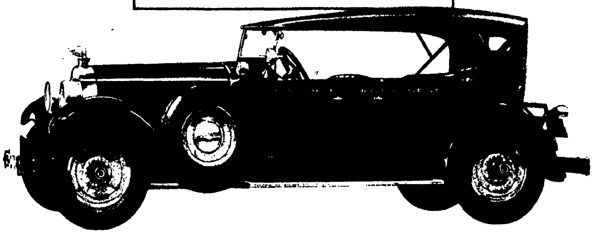

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Luca Della Robbia (1400-1482), the first of the famous Florentine family, developed to a point of artistic perfection the intricate technique of enameling clay.

Borrowing fire from Della Robbia

MASTERS of Art they were. Masters of enameling on clay. Their gems of modeling covered with brilliant colors are unequaled today. And the gifted craftsmen of Venice and Limoges have left us superb proof of their ability to apply enamel to metal.

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General Electric engineers have applied electric heating to processes used for bath-tubs and jewelry, for cast iron and bread, for tool steel and glue pots. In the G-E booklet entitled "Electric Heat in Industry" you will get some idea of its range of application and of the possible value of electric heat to any manufacturing business.

GENERAL ELECTRIC

H A V E A C A M E L

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"Have a Camel!"

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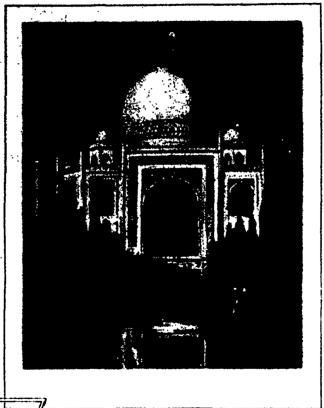
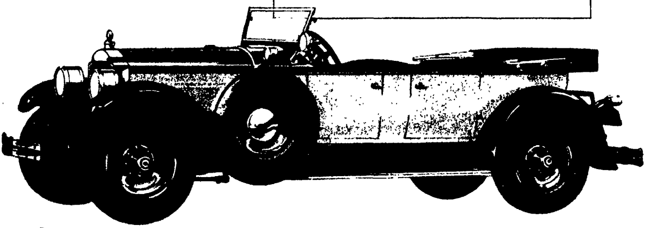




Enduring Style · Only an expert can point out the slight external differences which distinguish Packard cars built during the past six years. A Packard, no matter what its age or mileage, always stands out as a Packard.

The reason is easy to find. Packard has created an enduring style in motor car design. Packard has achieved that difficult combination of luxurious interior roominess and beautiful, slender exterior lines. Packard has no reason to make radical changes annually.

Like the beautiful proportions of Eastern architecture which centuries have been unable to improve upon, Packard lines have set a standard which the whole motor industry has been unable to more than copy.

And this famed stability of Packard appearance means much to every Packard buyer—it means insurance against depreciation. For depreciation is largely a matter of appearance.

The Packard owner knows that he is protected in the economical use of the long life built into every Packard chassis by Packard's policy of stabilized beauty of design.

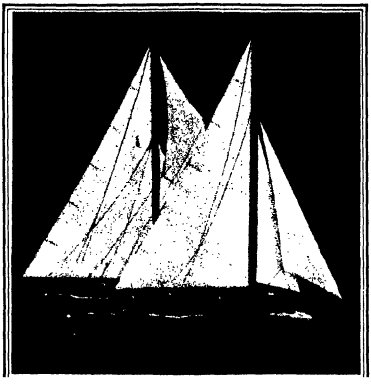
PACKARD

ASK THE MAN WHO OWNS ONE

PRINTED IN U. S. A.

SCIENTIFIC AMERICAN

SEPTEMBER 1927 *Thirty-five Cents a Copy*



SLEEPY SICKNESS
BY DR. SIMON FLEXNER

TELEPATHY—FACT OR FABLE?

WHY FLY WITHOUT RADIO?

SCIENTIFIC AMERICAN

September 1927 — *Edited by* ORSON D. MUNN — Eighty-third Year

CONTENTS

SEPTEMBER 1927

DEPARTMENTS

Flood

POSSIBLY 77,777,777 bright ideas, more or less, for preventing any more Mississippi flood disasters have been made. Most of them center about levees, reservoirs, reforestation, and new spillways. The odd thing is that most of these good people, who seem to have just become conscious of the problem this year, assume that the army engineers who have had charge of the job for decades have never even given these ideas a systematic canvass.

Of all the "bright" ideas, the "brightest" is the proposal to dig a parallel river channel all the way down river—double tracking the Mississippi, as it were. If we had this it would be fine. But by the way, it would cost, according to a statement in the *Engineering News-Record*, some 189,838,537,778 dollars—a mere trifle, of course.

Still, all these wild proposals are not a circumstance to those we shall hear next December when Congress meets.

Vast

"IS this not just another impracticable scheme?" "Is it really important?" In the July issue we devoted most of the Digest Department to a consideration of the proposed process for the liquifaction of coal, a method of turning coal into fuels like gasoline. A few of our readers remain incredulous about the assumed great significance of this new discovery.

We think it is likely to prove of tremendous importance. A. C. Fieldner, Chief Chemist of the United States Bureau of Mines, writing in the *Tech Engineering News*, points out its potentialities. We have a reserve of five billion barrels of petroleum, which undiscovered methods of recovery may increase to 26 million barrels, Our oil-shale deposits, not yet touched, contain 108 billion barrels, truly a vast reserve.

But compare even these stupendous figures with the potential liquid-fuel reserves contained in our lignite and coal resources, if the new liquefaction processes are brought to bear on it. There would be 595 billion barrels! This in a nutshell shows why we are watching with keen interest the newest developments in the liquefaction of coal.

Hoboes

THE Denver and Rio Grande Railroad has found a new way to deal with hoboes that ride freight trains. When they catch one they collar him and steer him to the nearest ticket office where they make him purchase a regular full fare ticket from the point at which he boarded the train. Last year they did this to 28,488 hoboes and extracted from them 18,393 dollars.

The railroad says the hoboes are influenced by the advertising of scenic attractions in the Rocky Mountains, in the same way as regular passengers!

We suppose the railroad is right about making these hoboes pay their fare. Yet, somehow we entertain a lingering sympathy for the poor hobo. On closer self-examination we discover the reason: some years ago—seventeen, to be exact—the writer of this note had a delightful hobo experience himself; he "hopped freights," ate occasionally, worked none. And today he remains loyal to the profession! What he *can't* figure out is, how these hoboes managed to dig up 18,393 dollars. Times must be better nowadays.

Currency

WITH the mortality rate of our paper money increasing at an alarming rate, the Treasury Department has determined to resort to amputation. The use of paper money has trebled in the last fifteen years; a dollar bill used to be good for twenty months; now it is worn out in six. Every year the Bureau of Engraving and Printing finds itself printing a billion new bills.

Cutting down the number of pieces of paper money would solve the problem, but we need all the bills we can get—and more. Why not, then, cut down each bill? It is not what it used to be in purchasing power, anyway. And locking over the advantages it will bring, such a move seems eminently worth while. It will save 2,000,000 dollars annually, it will solve the Bureau's problems, and it will be more convenient when once the public gets accustomed to the new ....

To the new size dollar bills—and the fives, tens and twenties, too—we extend a welcome. May we see lots of them!

Cover

THE two 75-foot yachts shown on our cover are attracting more attention among the racing yachtsmen than any yacht, big or little, of the present season. In the foreground is the 75-foot sloop *Katoura*, built this year. She carries the Marconi rig, and resembles the little 6-meter sloops. Abreast of her is the schooner *Vanitie*.


LOS ANGELES HARBOR

Among our Contributors

DR. SIMON FLEXNER

Since 1903, Dr. Flexner has been Director of the world-famed laboratories of the Rockefeller Institute for Medical Research. In this remarkable institution, under Dr. Flexner's direction, research work of the highest value to humanity has been and is continually being performed. On page 224, Dr. Flexner writes about one of the problems of medicine that is yet unsolved.

DR. WALTER FRANKLIN PRINCE

Dr. Prince's name has often figured prominently in the newspapers in connection with famous psychic investigations. It is pretty hard to make anything like an exact science of an intangible subject like abnormal psychology, yet those who, in reading his article on mind reading (page 210), suspect Dr. Prince of always favoring the psychic side would be surprised to know how often he has favored the other side.

Sir Richard Paget

The author of the article on the invention of human speech (page 204) is a British lawyer who specializes in the development of inventions. His recreations are music, acoustics, arts and crafts. He has performed some extremely interesting experiments on reproduction of human speech, and has literally made a real "talking machine."

Ernest Flagg

The author of the intriguing article on an ideally planned city (see page 238) is the well known architect of the Singer Tower in New York and the United States Naval Academy at Annapolis, as well as the Corcoran Gallery of Art in Washington. He tells us how living and business conditions can be enormously improved.

Prof. William K. Gregory

Among students of evolution, Professor Gregory, who contributes a lucid article on the controversy about man's ape ancestry, is known as one of a possible half dozen of the world's best supports in matters of organic evolution, where anatomy is involved. Especially is Dr. Gregory known to possess a judicial mind in things scientific.

D. H. Killeffer

The author of the article about "dry ice" (frozen carbon dioxide) on page 220, is not only Chemical Editor of the SCIENTIFIC AMERICAN but Associate Editor of *Industrial and Engineering Chemistry*, the foremost American journal of chemistry and the publication selected as the official organ of the great American Chemical Society.

Looking Ahead *with the Editor*

RATTLESNAKES

How one of the most peculiar ranches in the world—a rattlesnake ranch—is run will be told. The venom extracted from the snakes' fangs is regularly "milked" for serum-making. Running such a ranch is fascinating—to read about!

TROGLODYTES

In northern Africa, in the desert country 800 miles south of ancient Carthage, 30,000 people live in wells—circular holes in the ground. They seldom "come up for air" except when they die, when they are buried nearer the surface than they have lived! The peculiar life they lead will be described by Horace Ashton, Fellow of the Royal Geographical Society.

MOLECULES

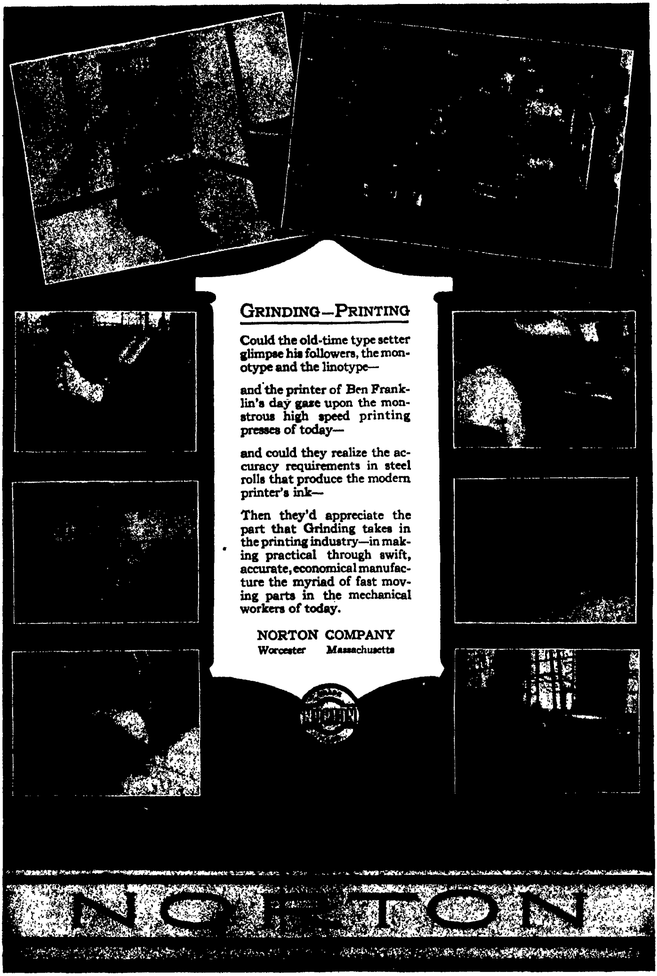
A whimsical writer might say that the atom, and more recently the electron, have received so much attention of late years that the poor molecule has almost been forgotten. In an early issue Prof. S. R. Williams of Amherst College will give the molecule a chance to prove itself as interesting as the atom and the electron.

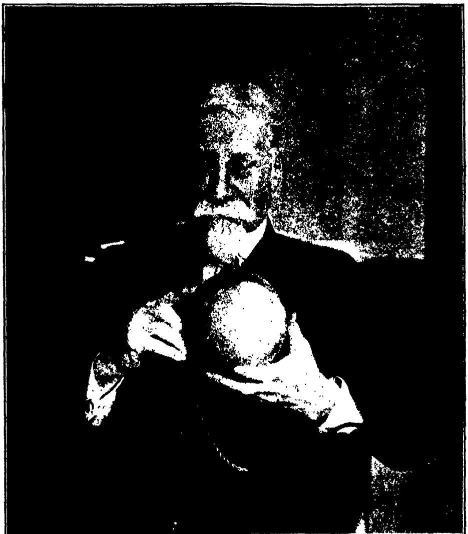
DODO

The dodo bird is extinct—everybody says "as extinct as the dodo," now and then—and so is the famous passenger pigeon. Man came and bludgeoned, killed them all, and seemed satisfied. Are the other birds similarly doomed? Read "Conservation or Extinction?" by Prof. Leon A. Hausmann, noted ornithologist, next month.

400,000,000

That is the aggregate horsepower developed by the 20,000,000 motor cars in the United States. Quite a power plant, isn't it? How the engines of these motor vehicles are tested forms the subject of a most informative article by Prof. Lockwood of Yale.

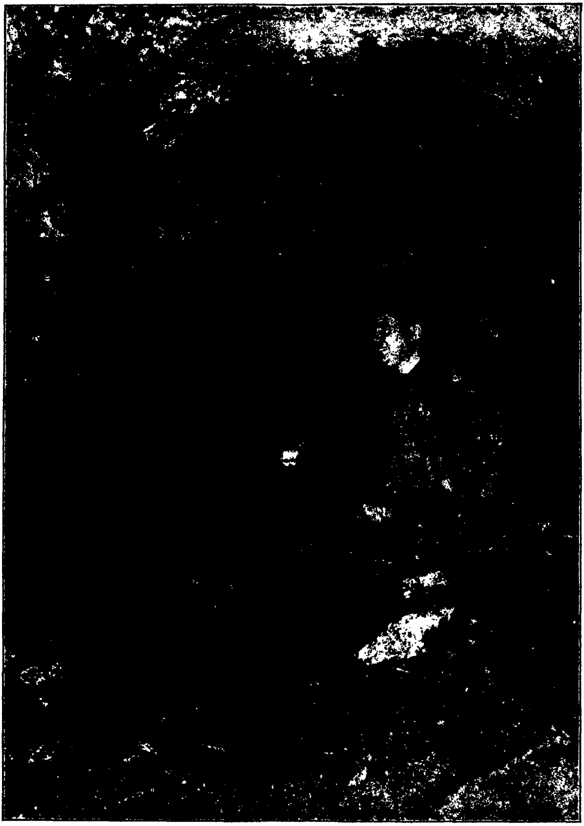

GRINDING—PRINTING
Could the old-time type setter glimpse his followers, the monotype and the linotype—
and the printer of Ben Franklin's day gaze upon the monstrous high speed printing presses of today—
and could they realize the accuracy requirements in steel rolls that produce the modern printer's ink—
Then they'd appreciate the part that Grinding takes in the printing industry—in making practical through swift, accurate, economical manufacture the myriad of fast moving parts in the mechanical workers of today.
NORTON COMPANY
Worcester Massachusetts
NORTON



P and A

DR. T. C. CHAMBERLIN

By common consent among scientists, Professor Chamberlin of the University of Chicago, strong and well in his 85th year, is the dean of American geologists. Specifically he is best known as a cosmologist, the famous Chamberlin-Moulton "Planetesimal Hypothesis" of the origin of the planets, announced in 1899, having in some form entirely superseded the old classic "Nebular Hypothesis" of Kant and Laplace. It asserts that the matter of which the planets are formed was torn from the sun by the attraction of a passing star. This matter, in the form of comparatively small, solid bodies called "planetesimals," gathered in "knots" which, as they grew, became planets. The hypothesis is explained in "The Origin of the Earth," by Dr. Chamberlin. Several modifications of the original Chamberlin cosmology have more recently won adherents, notably that of Professor Jeans of Cambridge University, that of Dr. Harold Jeffreys, also of Cambridge, and that of the late Professor Barrell of Yale. These are molten-earth theories, while Chamberlin's is a cold-earth theory. The fact that these newer modifications have been quite accepted by scientists has tended to obscure the main fact that the theory as a whole, involving an immensely important turning point in modern cosmology, is the epoch-making concept of Professor Chamberlin, and that the newer theories agree with his original theory in perhaps nine tenths of their main details



"Holing Through" the Hudson Vehicular Tunnel

The great vehicular tunnel between New York and New Jersey is to be known officially as the Holland Tunnel, in honor of its first Chief Engineer, the late Clifford M. Holland. It consists of two separate, parallel tunnels, one for eastbound, the other for westbound traffic. They are the largest in existence, the outer diameter, measured over the cast-iron shell, being 29½ feet. The roadways, 20 feet wide, will each accommodate two lines of vehicles. The tunnels are 8500 feet in length.

THE FINISHED TUNNEL

The Hudson River Vehicular Tunnel

A Big Problem of Ventilation, Requiring Nearly Four Million Cubic Feet of Fresh Air Per Minute

By J. BERNARD WALKER

THE opening of the great tunnels for the exclusive use of automotive vehicles beneath the Hudson River is an event of prime importance in the world of civil engineering; for not only in respect of its diameter and capacity is this the greatest tunnel in the world, but it called for an absolutely sure solution of an unprecedented problem of ventilation, since each tunnel would receive the exhaust gases of 1900 vehicles per hour. No such problem of ventilation, either in magnitude or character, has ever presented itself.

THERE are other vehicular tunnels in Europe and mainly in London, but they are much shorter, have a smaller traffic capacity, and hitherto they have handled a very large percentage of horse-drawn vehicles, sufficient ventilation being afforded by the natural draft through the portal openings.

The problem was investigated under three subdivisions: first, the amount and composition of exhaust gases; second, the physiological effect of these gases; and third, the best method of ventilation. The danger to be guarded against was an excess of carbon monoxide. It was realized that the amount of this given out in the exhaust must be definitely determined. There was no exact information on the subject, and, accordingly, under cooperative agreement between the New York-New Jersey Tunnel Commission and the United States Bureau of Mines, the Bureau undertook to carry out the necessary investigations. Here were made some 2000 tests on more than 100 types and sizes of motor vehicles. From these tests, the amount and composition of the exhaust gases from engines being operated under ordinary road conditions were established.

The tests to determine the physiological effects on individuals were performed at Yale University, and here it was determined that, if the poisonous carbon monoxide was kept down to four parts in 10,000 parts of air, the air would be entirely satisfactory for an exposure of one hour. Since a car would take only about ten minutes and a truck about 15 minutes to pass through the tunnel, this would provide ample safety.

ONE OF THE CAISSONS

Note relative size of man and caisson. Diaphragm was removed and shield entered the silt of the river bottom

A third series of tests to determine the best method of ventilation and the power necessary to accomplish it, was carried through on the campus of the University of Illinois in a concrete tunnel, served by a fan having a capacity of over 100,000 cubic feet per minute. The frictional losses in the concrete tunnel were determined, the air being taken off and entering at intervals such as would occur in the actual tunnel.

THE engineers of the tunnel now felt that the three questions of the amount of exhaust gases, their effect on the users of the tunnel, and the best method of ventilation, had been satisfactorily answered. Nevertheless, in order to be absolutely sure, they decided to demonstrate the proposed method of ventilation in a model tunnel. This work was done by the Bureau of Mines. A tunnel, whose cross-section was about one-third that of the Holland tunnel, was constructed

SINKING PILE CAISSONS TO ROCK

Eighty-four of these steel concrete piles were sunk to rock, 280 feet below surface. They carry a ventilating building

A MASSIVE TUNNEL SEGMENT

The tunnel is lined with machined cast-iron and cast-steel segments. These are held firmly together by alloy-steel bolts

in the Bureau's experimental mine at Bruceton, Pennsylvania. In each test eight automobiles were driven on the experimental roadway for a period of one hour, and during this time the air was sampled in various ways. Temperature and humidity readings were taken, and physiological tests were made on over 50 people who took part in the tests. There was for a time a division of opinion as to the best way to introduce the fresh air and take out the contaminated air from the tunnel, many people believing that the gases should be taken off at the roadway where they exhausted from the engine. Although this seemed plausible, the Bruceton tests definitely established that better results were obtained by introducing the fresh air at the bottom, and drawing the vitiated air off at the roof of the tunnel.

Just here we wish to state that this great thoroughfare below the Hudson is to be known as the Holland Tunnel in memory of the late Clifford M. Holland who, as chief engineer, organized the engineering staff, worked out the elaborate plans for the tunnel, and carried them successfully through in the earlier years of its construction.

For the data and photographs which accompany this article, we are indebted to the present chief engineer, Mr. Ole Singstad, who has completed the work.

THE ventilating plant, as will be readily understood, is of large capacity, and has called for the installation of four ventilation stations, one in the Erie Railroad yard, near the Jersey City end of the tunnels, one in the river, near the New Jersey pier-head line, one near the pier-head line, New York, and one at Washington Street near the New York terminal.

The traffic runs in one direction only in each tunnel. The fan equipment for driving the fresh air into the tunnel and exhausting the vitiated air is installed in each of the four large ventilator buildings above mentioned, and each set ventilates the tunnel half-way, each way, to the next ventilating building. The fresh air enters through louvered openings in the sides of the building and passes down the shaft to the duct which extends below the roadway, from which it enters the roadway just above its surface.

The circular tunnel is divided by two continuous diaphragms into three separate parts. At the center is the roadway section, which is 13 feet, six inches in height. Above and below are the air ducts, each of which, like the roadway section, is continuous from end to end of the tunnel. The air is forced by the fans continuously into the lower fresh-air duct, from which it passes on to the tunnel roadway through a continuous chamber on each side.

The chamber has a continuous steel plate in front of it, which leaves a slot opening, varying in width from three-fourths to one and three-fourths inches. These slots are arranged so that there is a continuous stream of fresh air entering the tunnel at the roadway level on each side throughout its entire length. This air mixes with the exhaust gases and they gradually rise and pass through openings leading into the exhaust duct above.

In order to insure a dilution in which carbon monoxide will not exceed four parts in 10,000, 3,761,000 cubic feet per minute of fresh air have to be introduced.

The fans are driven by alternating current motors, and their capacity varies from 81,000 to 220,000 cubic feet per minute, this variation being due to the different lengths and areas of duct to be served. Thus the fans ventilating the tunnel from the river shaft half-way up to the land shaft ventilate only 750 feet of tunnel, while the fans in the ventilating building on the opposite side of the river ventilate

TIGHTENING LINING BOLTS

The tunnel is remarkably watertight. These men, using a ratchet wrench, are bringing segments to a tight bearing

GROUTING THE TUNNEL

Liquid cement is driven through the cast-iron shell to close the voids between it and the surrounding sand or silt

feet.

...sepower to ventilate the ... maximum capacity. There ... high-velocity air current in the tunnel, although its atmosphere undergoes a complete change every one and one-half ... stream comes o... slots so gently ... your hand cann... mov...

The chief en... is of the opinion that this is the only really safe method of ventilation, judged from a fire hazard point of view. If a swift air current were blown through, and one of the motor cars caught fire, the flames might spread from one vehicle to the next and the draft would carry the smoke through the tunnel so that conditions would be unsafe, and there would be danger of panic. In the demonstration with smoke bombs at the experimental tunnel, it was found that, although the smoke was so dense that the men could not see their hands in front of their faces, the smoke did not spread more than 30 feet on either side of the source of the smoke.

THE MEETING OF THE SHIELDS

To the left is shown the cutting edge of the New York shield. To the right is the hood of the New Jersey shield

THE tunnels are 8500 feet long between the portals and each has a roadway 20 feet wide with a clear headroom of 13 feet, six inches. The exterior diameter is 29 feet, six inches. The tunnels are lined internally with concrete. The side walls are tiled with a vitreous white tile and the roadways are paved with granite block.

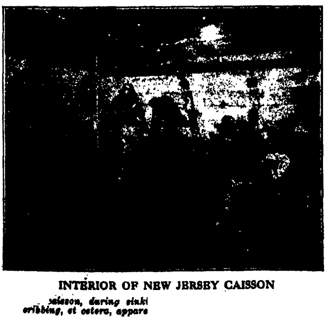
Each tunnel, which is built of segmental, cast-iron rings, was driven through the bed of the river by the well-known shield method. Each ring is 30 inches in width, measured along the length of the tunnel. Some distance to the rear of the shield was a concrete bulkhead, ten feet thick, in which were built four air-locks, of which the two upper locks were used by the men, and the two lower locks for material. Of the upper locks, one was used for the entrance or exit of men, and the other was for emergency, with the door facing towards the shield always open. The portion of the tunnel between this bulkhead and the shield was always under a pressure of air sufficient to hold the water out of the heading. The shield was pushed ahead by hydraulic jacks, each of 200 tons capacity. These used the forward end of the completed tunnel as an abutment.

Comtemporaneously with the excavation of the tunnel at the shore ends, large shafts were sunk, as pneumatic caissons, and the bottoms sealed. The shields were erected in the lower part of the caissons, temporary roofs were placed in the latter, and the chambers were put under compressed air. Openings were provided in each wall of the caissons before sinking, which were closed by temporary steel bulkheads. These were later removed ... shi... started on their way under the river. The steel boxes for the river caissons were sunk while the shields were being driven from the land shafts. When the shield approached the caisson, which had ...ched its position on the ... the tunnel, the temporary bulk... ere burned out. The shield then pushed into and through the caisson, whereupon it continued on its way below the river.

THE sinking of the New Jersey shaft was a most difficult problem. The caisson, 107 feet below water level, was on silt too soft to sustain the ultimate load, and the foundations had to be carried to rock, 260 feet below water level. This was done by sinking 84 steel-shell reinforced concrete piles, each 24 inches in diameter and 155 feet long below the cutoff.

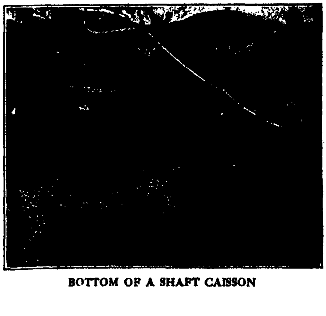
The tunnel was driven through various classes of material. The first portion on the New York side was built through sand, which was withdrawn through the tunnel. When the river silt was reached, the shield was closed with steel doors and it was forced bodily ahead, the silt being so plastic that it flowed around the advancing shield. The pressure involved was so great that it became practically impossible to guide the shields by varying the pressure on the jacks, and the keeping of it in alignment was done by opening the necessary doors in the face of the shield.

In conclusion it is gratifying to be able to state that the tunnel is unusually dry, this being due largely to the use of an alloy-steel bolt which is much smaller than would be required if an ordinary carbon steel bolt had been employed. The tunnel also is of unusual strength, as is shown by the fact that, in spite of its great diameter, there is less deformation in it than is found in some tunnels of smaller size.



INTERIOR OF NEW JERSEY CAISSON

...aisson, during sinki... cribbing, et cetera, appare...



BOTTOM OF A SHAFT CAISSON

The Invention of Human Speech

Articulation and Phonation Have Been Combined to Form a Ready Means of Thought Transference

By SIR RICHARD PAGET, BART.
Fellow of the Physical Society of London, Fellow of the Institute of Physics (England)

HUMAN speech as it has come down to us at the present day is a combination of two separate "inventions" or arts. There is the art of phonation or humming which is produced by the passage of air between the vocal chords, just as the sound of a trumpet is primarily produced by the passage of air between the compressed lips of the trumpeter. In each of these cases the airstream is divided up into a rhythmical succession of puffs which produce in our ears the sensation of a musical sound. The other invention is that of articulation, that is, the method of altering the internal shape of the cavity or body of the instrument through which the humming sound is passed, namely by the movements of the human tongue, lips and throat. These two arts are essentially different and fulfill different purposes.

PHONATION—the humming sound produced by the vocal chords—is the language of our emotions. It is found in the lower animals, and was doubtless used by the primitive ancestors of man to express their emotional states—such as anger, challenge, fear, warning, pleasure, pain, love—long before speech itself was invented. Articulation, on the other hand, is the language of the mind. It is the method by which we convey our thoughts, as distinct from our emotional states.

Articulation can be used by itself, that is, without phonation, as when we blow air from our lungs through the cavities of our throat, mouth and nose without allowing our vocal chords to come together sufficiently to set up vibration. In this way the movements of articulation produce whispered speech. In the English language, we can make all the various speech sounds—vowels, diphthongs, and consonants—without the aid of the vocal chords.

When, instead of simply blowing air through the vocal cavities, we blow pulsating or vibrating air (due to vocal-chord action) and then make movements of articulation, we get the phenomenon of voiced speech. Voiced speech has many advantages over the whispered variety. It can be heard from 10 to 20 times as far, it carries an emotional as well as an intentional or mental message, and it has the quality of melody from which human song has been developed.

It is easy to see why, when once the methods of articulation, as a means of thought-transference, had been discovered, articulation itself was usually combined with phonation. It is not so obvious how the transference of thought by articulation came to be devised.

The probability is that articulation was developed from the earlier device—common also to other animals—of explaining ideas by bodily gesture. A dog who bars the passage to his foe shows his teeth, he greets his friend by jumping up and down, he leads his friend to the chase by running forward in the direction he has chosen and then comes back to encourage him to follow.

Underwood and Underwood

ARTIFICIAL VOICE PRODUCTION

Sir Richard Paget and his devices with which human speech can be imitated

So with man. He no doubt used his hands and face and body as a whole to indicate his wishes or his ideas. His "language" (at that time) was primarily a gesture language, comparable with the gesture language of the American Indians or of deaf-mutes, but combined with emotional cries, and calls for attention.

Then, as man became more and more an artist and craftsman, his hands became too much occupied and his gesture language became centered in his face and jaw, and his lips and tongue. Gestures which had previously been made with his hand, or with his hand and mouth together, became centered entirely in the mouth, and the human tongue took on the gestural functions of the human hand.

Let the reader try the experiment, before the looking-glass, of making a few simple gestures with his tongue. If he shakes his tongue, as his hand would shake a mat, and at the same time phonates with his vocal chords, the result is a "word," like "olly-olly" or "orry-orry." If he makes a digging gesture with his tongue, beginning with the tip of the tongue touching the roof of the mouth, then plunging it downwards behind the lower teeth, then flinging it upwards and slightly backwards towards the roof of the mouth, he will get a word like "tah-ree" or "tah-dee."

Dr. Whymant, who is an authority on early Chinese, Japanese and Polynesian language, tells me that "ore-ore" did mean "shake," and that "tadi" meant "dig," in some of these early languages.

Many of the Aryan root-words such as "da," meaning "give" (from which our word "data" is derived), "ap," meaning "seize" (from which "apt" is formed), "ku"—"swell out," (whence cave), "mar" or "mal"—grind" (mortar mill) "dhargh"—"make firm" (whence drag), seem to have been originated in the same way—namely by making a pantomimic gesture with the tongue, lips or jaw to indicate the action or quality intended to be conveyed.

EVERY such pantomimic gesture produces a corresponding change in the interior form of the vocal cavity, and thus produces a change in the character or intensity of the resultant sound. In recognizing speech by ear we are really (subconsciously) listening for evidence as to the movements and postures of the tongue and other organs of articulation and, having identified the movements which produced the speech sound we (again, subconsciously) decode these movements back again into thought.

It is in this way that man has learned the method of thought-transference by articulation. The question arises—how do the movements of articulation produce the sounds of speech? Figure 1 gives in diagrammatic form a section of a human head showing the vocal cavities. The vocal chords are a pair of lips (about one-half the size of the lips of our mouths) lying fore-and-aft across the top of the windpipe. Immediately above them are another pair of lips, those of the false vocal chords, which are much longer and thinner and

can be moved downwards so as to cover the vocal chords or upwards so as to make a bell mouth into which the orifice between the vocal chords opens out.

Still further up is the epiglottis. This is a movable flap at the back of the tongue which can be bent back and down, as in swallowing, so as to cover the false and true vocal chords, or partially back to constrict the passage at the back of the tongue. Or it can

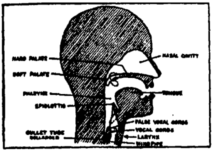


FIGURE 1

lie close up against the back of the tongue.*

The soft palate is the "valve" which closes the passage from the pharynx to the nasal cavity. It can be moved into a variety of positions (such as that shown in dotted lines) to open the passage to the nasal cavity or to cooperate with the tongue in making a complete or partial closure of the air passage from the lungs to the lips.

The tongue can make complete or partial closures in a variety of positions against the hard palate or the teeth, while the lips, besides making complete or partial closures, can also protrude more or less so as to make an additional cavity in front of the teeth.

Figures 2, 3, and 4 show the approximate positions of the organs which produce the sounds "a" as in "ah" or "calm," "i" (ee) as in "eet" and "ɔ" (aw) as in "more." It will be seen that at each fresh posture of the tongue, lips and epiglottis, the interior form of the "body of the instrument" through which the airstream passes is changed. Generally speaking, there are always two main cavities formed, one behind the hump of the tongue and one in front. Each of these cavities has its own musical note to which it "resonates."

The effect of the movements of articulation is therefore simply to vary the tuning of the cavities through which the airstream passes. When we make a complete closure, as in articulating a "p" or "t" or "k," all resonance suddenly ceases, but it begins again as suddenly when the closure is released. The only difference between a "p" "t" or "k" is that, as the closure is released, the tuning of the cavities alters in a *different* way in each case and we are thus able to identify *where* the closure was made by the way in which the resonances change. All these postures and gestures of articulation can be imitated in models, so as to produce recognizable speech sounds, without imitating at all closely the actual forms of the vocal cavities which produce them. It is only necessary to have the same number of cavities present and to tune them to the same pitch as that of the cavities of the mouth which produce the sound in question. The principle of tuning is substantially that of the "Helmholtz resonator," that is, the pitch produced depends on the relation between the volume of the cavity and the size and neck-length of its orifice. The bigger the volume—the lower the resonant pitch; the bigger the orifice—the higher the pitch. Increasing the neck-length of the orifice lowers the pitch.

FIGURE 5 shows in section a number of vowel-sounding models, made of plastic modeling clay and provided with "vocal chords" consisting of a rubber strip laid edgewise across the air passage so as to vibrate laterally when air was blown past it. Each model provides two resonating cavities connected together "in series." These models will produce recognizable vowel sounds. The consonants—which, as will be remembered, are produced by gestures of the organ of articulation—require moving parts of some kind to vary the start and stop and vary the resonances in the appropriate manner.

Figure 6 shows a model designed to articulate the consonants "m" or "n" with the vowel "i" (as in "it"). Closing and releasing the mouth of the model by hand articulates "mi," closing and releasing the "central orifice" between the tongue and the palate produces "ni." The two movements in succession articulate the name "Minny."

The consonants "p," "t" and "k" can be recognizably produced by employing a flexible rubber tube as the vocal cavity and varying its interior form by pinching the rubber from outside.

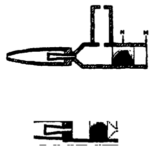
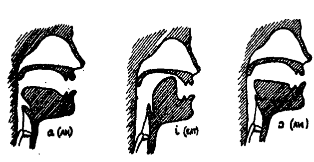


FIGURE 6

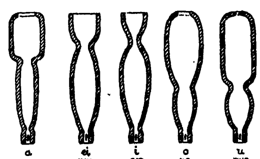
The associated vowel quality is given, as before, by giving the tube a waistline of the appropriate height and size. With such a resonator—shown in Figure 7—closure and release of the mouth of the tube gives "p," closure and release in the "t" and "k" positions give the corresponding consonant sounds.

Finally, many of the speech sounds can be produced by using the human hands as a vocal cavity, in which three fingers, held side-by-side, act as a movable tongue to divide the cavity into two resonators. In this device, which I have named the "cheirophone," the air, which may be supplied by bellows or by the performer's mouth, passes through an artificial larynx containing a reed which produces the "phonation," while the performer's fingers produce the articulation. It is thus possible to speak simple sentences such as "Oh Lilah, I love you"—"Hullo, London, are you there?" and so on. Some sounds, such as "k" and "t" are difficult to produce, owing to the difficulty of obtaining airtight closures. The human tongue is far from being an unruly member, but like the best of automobiles, it needs a good driver. Let us take a pride in driving it well!

* I am indebted to my friend, Professor G. O. Russel, of Ohio University, for much new information as to the action of the false vocal chords and the epiglottis in articulation.



FIGURES 2, 3 AND 4



OUR POINT OF VIEW

NAVAL LIMITATION

IT is altogether reprehensible that the success of the naval limitation conference at Geneva should have been imperilled by the unfair, and indeed in many cases positively mendacious, propaganda that was carried on in the daily press before and during the meetings of that most important gathering. Unfortunately, questions of naval strength, involving, as they necessarily do, matters of the strategical situation of the various countries concerned, are not intelligible to the average layman. The various newspaper correspondents at Geneva were dependent for their so-called facts upon the naval officers of the various navies concerned. "Parity," that word which has been bandied about so freely, cannot, in the nature of things, be determined by the mere questions of total tonnage or total numbers of ships. The strategical situations of the United States, Great Britain and Japan are widely different, and it should have been the part of the naval men who have informed and guided the correspondents of the daily press, to keep before the people of the world these wide differences, and to show why Japan calls for many submarines, Great Britain for many cruisers, and the United States for absolute parity in every class of ships.

The United States realizes the great debt of the Allies to the British Navy, which for four years held the German fleet fast in its grip. Had the enemy broken through to the high seas, not a single American regiment would have sailed for France, nor could the colonials have gathered from the four corners of the earth. The desire of the British for sufficient small cruisers to safeguard her sea routes is reasonable.

However, at the present writing, it looks as though the conference was going to weather this storm of unfair and misleading newspaper propaganda, and that the three leading navies concerned will get together on a basis which will recognize the strategic situation and the consequent necessities of each nation, and at the same time maintain the hard-and-fast 5-5-3 ratio determined upon at the earlier Washington conference, when battleships and airplanes only were covered.

Suspicion, distrust and jealousy should never be permitted to enter the doors of such a conference. Misrepresentation, above all, should be banished. The surest measure of success at Geneva lies in the belief by each nation in the honor and good faith of the other two nations, and a determination that good sportsmanship shall prevail throughout the whole deliberations.

SAVE THE WATER

IF someone should tell you, casually, that New York City wastes 280,000,000 gallons of water per day, you would probably receive the statement with a smile of incredulity. Nevertheless, we have the authority of the Water Works Research Bureau of this city for the statement that this is the amount of water now expended to no useful purpose, and that, expressed in terms of dollars and cents, this means that New York City is throwing 20,000 dollars daily into its sewers.

In bringing drinking water from reservoirs which, as in the case of New York City, are approximately 100 miles distant, and then distributing it through miles of water mains, there will inevitably be certain losses by leakage. These, however, are insignificant, compared to the wastage which occurs through the careless and extravagant use of water, which always occurs with an unmetered supply.

An unmetered supply is an encouragement to waste, not, of course, on the part of everyone, but as regards the great majority. "Easy come, easy go" is never so true as in the use of water. Why call in a plumber to fix a leaking tap or faucet when the water so lost passes harmlessly into the drainage pipe and causes the householder not the least inconvenience? One does not have to look very far to note that, in the round of daily life, the "grown-up" easily reverts to the carelessness and extravagance of childhood when the conditions are such that "you may take all you wish."

But we must remember that somebody has to pay the 20,000 dollars a day which is thrown by the careless user of water into the city's sewers. It has to be made good by building, every few years, additional reservoirs to keep pace with the demand. Thus New York will pay 350,000,000 dollars to develop the Delaware River watershed for an additional supply of 600,000,000 gallons, and this means a proportional increase of taxation. It means, furthermore, that the conservative users of water have to pay out of their pockets for the extravagance of those who waste wilfully.

What applies to New York City is true of all municipalities that fail to install meters. It has been estimated that by metering it would be possible to cut the water use of Chicago nearly in half, without subjecting the citizens to any inconvenient limitation of their daily supply. New York's average per capita daily use is 139 gallons with 26 percent of the supply metered; Chicago, unmetered, uses 296 gallons per capita; but Los Angeles, 99 percent metered, uses only 119 gallons per capita. The moral is obvious.

Lawrance

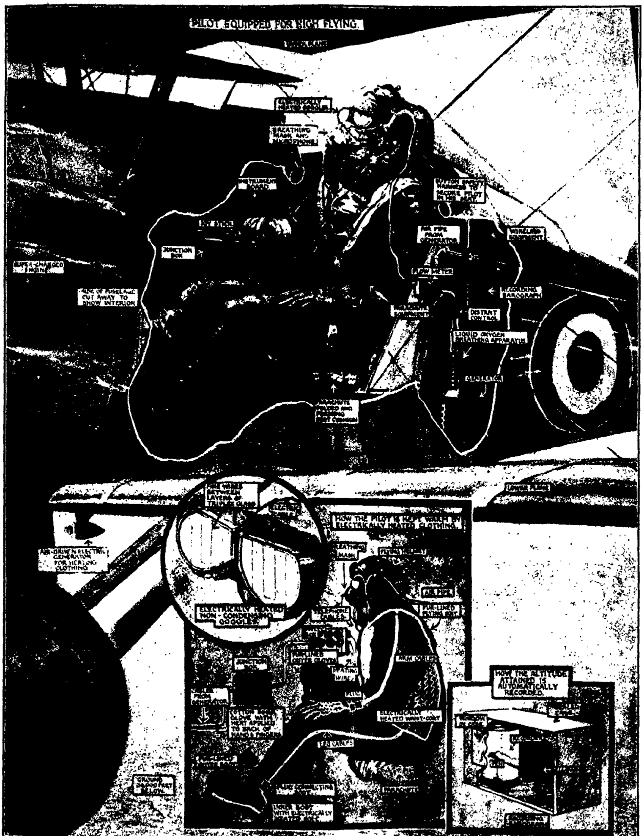
WITH the successful flight from San Francisco to the Hawaiian Islands of Smith and Bronte, one more chapter has been written in the amazing series of trans-ocean flights that have marked the past two months. Two civilians, in a small single-engined monoplane, flew in practically continuous foggy weather, and apparently without any sight of the ocean below, yet nevertheless they hit their objective, a most remarkable feat of navigation. Again it was the air-cooled engine designed by Charles L. Lawrance (See page 148, et seq., August, 1927, SCIENTIFIC AMERICAN) that carried the plane through. The word "heroic" can scarcely be applied to a man who sits with pad and pencil over a drafting board; but we think that to no one is greater credit due than to Lawrance, whose air-cooled engines have made these record-making flights possible.

WANDERING OIL WELLS

A RATHER dramatic proof of the reliability of the oil-well surveying machine, which we described in the article in our July issue entitled "The Wanderings of an Oil Well," has been afforded by two wells which are being drilled in the southwestern oil fields. Both wells are in the famous Spindletop field. One, known as Oakwood Number 12, had been driven down 2255 feet; the other, McLean Number 14, was down about 3500 feet, when "the two drill-stems ground into each other."

When the wells were started they were 84 feet apart, and it is estimated that the angle between the two holes at the point of intersection is two degrees and ten minutes. It was with great difficulty that the interlocked stems were pulled apart.

Oil men relate that only one previous case of this kind is recorded, that occurring in California, when two wells that were 300 feet apart at the surface intersected during the later drilling. The vertical and plan views in our July issue showed that the deviation from vertical was 517 feet at the 6000-foot level, and that in plan the well wanders around three sides of a rectangle.



Courtesy of The Illustrated London News

Flyer Equipped For High-Altitude Work

At the recent display of the Royal Air Force in England, much attention was focused on the events in which fast-climbing planes attempted to break existing altitude records. In order to do this, the planes and their pilots had to be specially equipped. The engine will not function properly in rarefied atmosphere, so it is necessary that it be equipped with a supercharger. Thus sea-level conditions can be simulated at extreme altitudes. The pilot must be kept warm in the low temperatures of the upper regions and this is accomplished by means of electrically heated clothing. To compensate for the lack of oxygen in the air, a generator is supplied for producing that life-sustaining gas. The details of the equipment are given in the illustration reproduced above.

Odd Stars

The Search for Exceptional Stars---Some Unusually Bright, Some Exceptionally Faint, Others Very Rapid---Forms an Intriguing Specialty for the Modern Astrophysicist

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mt. Wilson Observatory of the Carnegie Institution of Washington

THE astronomer is always seeking new worlds to conquer. No matter how far he has been able to push his advance, there is always something just beyond which tempts him to renewed efforts. Indeed, he is as insatiable as the traditional Yankee farmer, who, being reproached by the parson for undue love of this world's goods, and in particular for the purchase of land, replied: "I don't need so much. I only want to buy up all the land that adjoins mine." As he was not a resident of an island, this policy might lead him rather far; and we star-gazers own that the tale describes us.

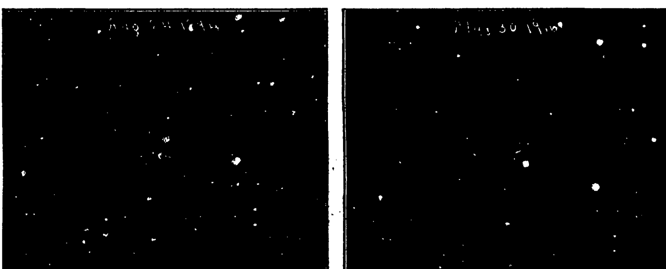
There is always a particular interest in the exceptional objects which lie outside the general run—for example, stars which are unusually bright, or especially faint. One is not speaking, of course, of their appearance to our eyes, which is so greatly affected by differences in the stars' distance, but of their real brightness. The apparent brightness is a very easy matter to measure—at least if we are contented with an accuracy of 10 or 15 percent; but to find the real brightness we must determine the star's distance, and this demands more work. We have now, however, so many good ways of measuring, or at least estimating, stellar distances, that this obstacle, once almost insurmountable, is no longer the barrier that it used to be. But, when we seek after stars which lie outside the general run, we have new troubles of our own. How can we pick them out from the great mass of others?

Consider first the stars of great luminosity, which, as we say technically, are very bright in absolute magnitude, and exceed the sun's output of light by a thousand-fold or more. There is no trouble in seeing such stars—even if they are far in the depths of space they will be fairly conspicuous. A star like the sun in brightness will be visible to the naked eye only if its distance from us does not exceed 60 light-years. This is fairly near by, as stellar distances go, and the great majority of the stars which are visible without optical aid are farther off, and of course brighter. But a star 10,000 times as bright as the sun can be seen without a telescope, if it is anywhere within 6,000 light-years; and with so vast a region of space in which to search we might expect to find a good many. They will look, however, just like the fainter stars which lie nearer us, and our problem is to pick them out.

WE have now two good ways of doing this. First, the spectra of these very bright stars show distinctive peculiarities—some of the lines being unusually strong, and others weak, in comparison with stars of about the same temperature but lower luminosity. Secondly, these stars, as spectroscopic observation shows, are moving in space at about the same rate as the sun—indeed, a little more slowly. Hence at these great distances their apparent motions across the sky will be exceedingly small. These "proper motions" have been observed with great care for all the brighter stars, and we have therefore another important guide. But it is not an infallible guide, for, if a star happens to be moving straight towards the sun or away from it, it will appear to be standing practically still in the heavens, no matter how near it may be or how rapid its real motion.

Study of the spectrum enables us to pick out these cases and reject them. We are left with the problem of determining the actual distances of the stars which we have already identified as exceptionally bright, and this is hard, because the parallaxes are very small. But in many cases, notably among the members of star-clusters and star-clouds, we can solve the problem, and our present knowledge of the very luminous stars is fairly satisfactory.

The most luminous known star is a variable, S Doradus, which is in the Smaller Magellanic Cloud at a distance of 100,000 light-years, and gives off



Yerkes Observatory

DETECTING STELLAR MOTION

Barnard's star in Ophinchus, having greatest known proper motion. Double plate showing marked change in position in 22 years

when at its brightest half a million times as much light as the sun does. Such tremendous stars are very rare. If we restrict ourselves to the more moderate limit of 10,000 times the sun's light we shall find, according to Kapteyn, only one star of this sort among 200,000 stars as bright as the sun, provided that we make a census of all the stars in some vast but circumscribed region of space.

When we pick those visible to the naked eye we include all stars of the brighter sort which lie within a region of space a million times greater in volume than for the fainter ones, and so our minority is likely to be turned into a majority although the intermediate stars, 100 times as bright as the sun, outnumber both the other kinds in our new count.

For the very faint stars, which give off less than a thousandth part of the sun's light, the problem is very different. Such stars are really very abundant; we believe now that there are more of them in any given million cubic light-years of space than of all the brighter ones taken together. But the fact that our observations are controlled by the apparent brightness of the stars now works heavily against us. A star a thousand times fainter than the sun, to be visible to the naked eye, would have to be less than two light-years distant, and no known star is so near. If we change our limit of apparent brightness—make it, for example, a thousand times fainter—we shall now include all the faint stars of the kind we are discussing which are nearer than 60 light-years, and there should be some dozens of these—perhaps a few hundred. But in lowering our limit of apparent magnitude we shall at the same time have let into our lists millions—literally millions of stars which are really brighter and farther off, but look about the same.

OUR problem is now that of the needle in the haystack, and would be hopeless were it not for other aids. For such faint stars, wholesale spectroscopic observation by the million is impracticable; but the proper motions remain. These faint stars have, on the average, rapid real motion, and once they are so near us their apparent proper motions will usually be very large. Our problem is then to find out, among a million or so of stars, those which move fastest in the sky; and this can be done almost by machinery. We have only to photograph the heavens with a wide-angle astronomical camera, to repeat our plates a few years later, and to compare the two. We shall need a "blink-microscope," that ingenious apparatus which can be focused on two different plates of the same field, so that by shifting a little lever we see alternately one and the other as we look through the eye piece. By proper adjustment, we can bring all the stars which have not moved perceptibly to just the same position in the two cases—and then any star which has moved will appear to jump as the lever is shifted back and forth. This makes it very easy to pick out the one moving object among ten thousand—and incidentally it leads to the discovery of swarms of variable stars, asteroids, and so on. One can make a blink microscope, crude but good enough to illustrate the principle involved. On a paper place two groups of heavy dots, identical in pattern except that one dot will have a new position in one group. Hold a card on edge separating the groups, bring the eyes close to the card and open and close either eye alternately and rapidly. The one dot betrays itself by dancing.

WHEN once we have picked out the stars of large proper motion, the rest of our job is straightforward. We must photograph them with large telescopes, when the earth is in opposite parts of its orbit, and find the parallax by the familiar range-finding methods. These stars are near us, and have large parallaxes which can be measured with satisfactory percentage accuracy. Some of them, perhaps most, will turn out to be objects at moderate distances—20 to 50 light-years; and with very rapid real motions in space. But there will be others which owe their rapid apparent motions not to great speed, but to unusual proximity; and here at last we shall reach our objective.

The nearest known star was discovered in this way—Innes's faint companion to Alpha Centauri, which is moving in space along with it, but appears to be a little nearer to us (four and one-quarter light-years); and so was the second, Barnard's star, which is only six light-years away.

Another star of the same sort has just been added to our lists. It is a 13th-magnitude star in Virgo, and is known as Wolf 359, since it bears this number in the list of proper-motion stars discovered photographically by Professor Max Wolf at Heidelberg. The photographs show that it has the remarkable proper motion of 4".84 per year—surpassed by only six stars known at the time of its discovery. So faint a star can be observed for parallax only with a very large telescope, but Van Maanen, with the 100-inch reflector at Mt. Wilson, has obtained an excellent series of plates, and has just announced his result, a parallax of 0".404+-0".009, making the star's distance eight light-years—a little less than that of Sirius. Only two other known stellar systems, that of Alpha Centauri, and Barnard's star, are nearer. The real motion of this star (at right angles to our line of sight) is not remarkable, being 57 kilometers a second. The radial velocity is shown by the spectrogram to be approximately 90 kilometers per second, that is, the star is approaching us at this rate.

A simple calculation shows that about 70,000 years hence it will be as near as Alpha Centauri is now, and will have a proper motion of 17" per year. Even so it will be fainter than the 12th magnitude. Its absolute magnitude, compiled by Professor Kapteyn's formula, is 16.5, which in plain English means that it gives out only one fifty-thousandth part of the sun's light. This is much less than for any star which was previously known—the next in the list, Innes's star, being four times brighter.

The spectrum of so faint an object is naturally of great interest, and in spite of the extreme feebleness of its light, Humason has succeeded in observing it with the great reflector and a spectroscope designed especially for very faint stars. The photographed spectrum is only about a quarter of an inch long, but shows many details, sufficient to place it in the spectral class M 6, which corresponds to almost the lowest temperature which is found in stellar atmosphere. The hydrogen lines are bright, as is the case in some other very faint stars—no one yet knows why. As might be expected from this spectrum, the star is very red, and is only about one-sixth as bright photographically as to the eye.

WHAT its real size may be is a little hard to estimate, for we have only the scantest data to guide us in the case of such low temperature, but these data indicate that the star is probably of about one tenth of the sun's diameter—no bigger than Jupiter, and perhaps as small as Saturn. Its mass may be roughly estimated, by means of Eddington's relation between mass and brightness, as about one tenth of the sun's, which would make the density something like a 100 times that of the sun, or very likely more. It looks, therefore, as if this star was far advanced in the scale of density, although still falling very much short of the enormous density of white dwarf stars like the companion of Sirius.

There are still as good fish in the sea as were ever caught. Professor S. E. Ross of the Yerkes Observatory, who is engaged in a systematic search for proper-motions with the aid of Professor Barnard's splendid collection of plates, has just announced the discovery of a thirteenth magnitude star in Cancer with the very large proper motion of 5".40 per annum. In a couple of years, when the parallax observations are made, it may turn out that this star is even a nearer neighbor.

Specimens From the Telepathic Mine

There Is a Mine of Interesting Evidence Tending To Establish the Genuineness Of Thought Transference

By WALTER FRANKLIN PRINCE, Ph.D.
Research Officer, Boston Society for Psychic Research

IN a short article I can only casually exhibit a few "specimens," and assure readers that they represent many careful tests; there is not space to describe the details of even one essay.

Charles Richet, Professor of Physiology at the University of Paris, tells us that on July 2, 1888, "Leonie" spent all day in his laboratory, and when in a state of hypnosis at 8 P.M. was asked by him (referring to a man whom she had seen several times but not recently): "'What has happened to M. Langlois?' 'He has burnt himself,' Leonie replied. 'Good,' I said, 'and where has he burnt himself?' 'On the left hand. It is not fire. I don't know its name. Why does he not take care when he pours it out?' 'Of what color,' I asked, 'is the stuff which he pours out?' 'It is not red, it is brown; he has hurt himself very much—the skin puffed up directly.'"

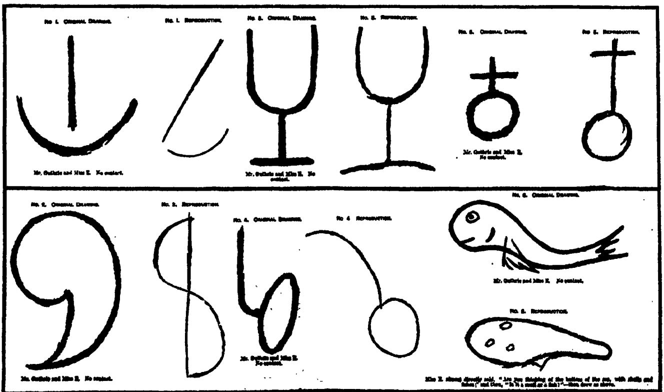
Every detail of this was exactly true; the accident happened four hours before the utterance, and Professor Richet declares that neither had he mentioned to anyone the burn received by M. Langlois on his left hand when he too hastily poured bromine from a bottle, with consequent blistering, nor could Leonie possibly have heard of it from anyone else.

If this incident stood alone, no authority on earth could make me believe that there had not been a mistake, but there are a multitude of such incidents on record too well vouched for to be lightly put aside. Certain of these incidents within the circle of my own observation have already been told in print.

DURING an indefinite period in the past, persons have thought that they had evidence in their own experience for mental communication, but proper recording of supposed instances was practically never done, until within a recent period. The (English) Society for Psychical Research did much pioneer experimentation in telepathy, and still furnishes occasional studies.

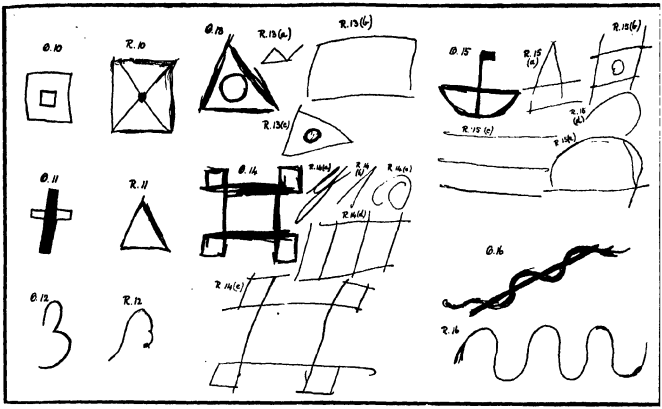
Mr. Malcolm Guthrie, J.P., seems to have been one of the earliest and most indefatigable hunters for good subjects and experimenters for telepathy that the Society for Psychical Research produced. Apparently, also, he was a careful experimenter, as the descriptions of his technique show. In the Society for Psychical Research *Proceedings* of 1883 may be found a summary of about 150 experiments for the transfer of drawings (that is, the "agent" makes a drawing out of sight of the "percipient," and the latter draws the impression she gets), the percipient being part of the time Miss R. and part of the time Miss E., the agents varying. The drawings which are reproduced in this article represent the complete and consecutive series of a single sitting. No one was in the room but the agent and the percipient. Probably there was no other quite so successful consecutive a set of six in the whole series as this, but there were many remarkable successes, witnessed by various persons.

In 1885, Mr. Guthrie reported further experiments, in which two shop girls, named Relph and Redmond,



SIX TESTS IN THOUGHT TRANSFERENCE, MADE IN ENGLAND

The originals were drawn in another room from that in which the subject was placed. To catch the thought involved in the drawings usually took a minute or two. These tests are described in the Proceedings *of the Society for Psychical Research, Volume II, pages 24 to 48, where a considerably larger number of tests of the same general nature are also described in detail*



BARON VON SCHRENCK-NOTZING'S EXPERIMENTS IN MENTAL TELEPATHY

In each case there is an original sketch (marked O) made by those who conducted the tests. Near each original is the sketch or sketches drawn by the recipients. Several efforts were sometimes necessary to get the picture, and in some cases there was failure

were the subjects. There were varied conditions, and varieties of experiments. In some sets the tests were solely written; sometimes agent and cipient were in physical contact and sometimes not. Several persons in turn acted as agent.

The following were experiments without contact, all consecutive: Miss Relph, percipient. Others present, besides Miss Redmond, were Dr. Hicks, president of the Microscopical Society of Liverpool; Mr. Birchall, Honorary Secretary of the Literary and Philosophical Society of Liverpool, Mr. John Mr. Guthrie, J.P. Subject blindfolded, and with back to company.

1. Persons present pricked palm of left hands with pins. Answer: "Is it a tingling pain here?" (touching palm of left hand.)

2. All pricked back of necks with pins. Answer: "Is it a pricking in the neck?" (touching back of neck.)

3. Mr. G. held gold watch against his coat. Answer: "Are you looking at something yellow? Is it round; something like an orange? But it is not an orange."

4. Mr. G. held a pair of bright steel pincers, closed. Answer: "Is it something bright? I saw a flash of bright light, but no shape."

5. Object, a piece of bluish-green silk, trapezoid shape. Answer: "Is it blue? A greenish blue? Shape not well defined."

On another date, Messrs. Johnson nd Guthrie being present with the vo young women, experiments in hinking of pictures were tried, the subject being written, not spoken. he first, "Too Late," one lately on hibition with many others, Miss Relph visualized and named; the

Does Mental Telepathy Ever Take Place?

the firs

has ever been demonstrated. There have been innumerable cases that bear strong earmarks of the genuine—indeed, most of us occasionally experience them—yet it is extremely difficult to prove them in a thoroughly scientific manner. That is, the criteria of a truly scientific proof are distinctly higher than those most of us are usually willing to accept in our daily lives as establishing truth. In psychical research, seeing is not necessarily believing. The true, disinterested, scientific psychical researcher doubts everything and is vastly more rigid in his demands than the casual amateur. Such a researcher is Dr. Prince, the author of the accompanying article. —*The Editor.*

second test was da Vinci's "Last Supper." Guthrie mentally pictured Jesus as holding a goblet, while Judas dipped something into it. Miss R. said: "Is it the last days of somebody? Somehow there seems to be a dying man, and a lot of people in the room. A bed with a dying man, and some one holding a paper or something to him, or else he is holding it." Even this technical failure is curiously like the truth. Then the picture "Dante Meeting Beatrice, et cetera" was chosen, but Miss R. got no impression. The following one, "The Flight into Egypt" was correctly named in about four minutes. "Mary Anderson" was a failure, but "Ellen Terry as Portia" succeeded. Just two more experiments of the kind v made; in one there was no impression, and the subject of the other was wrongly given.

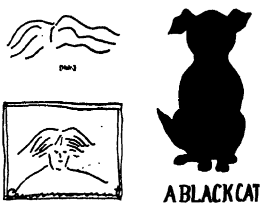
In 1889 Professor and Mrs. Henry Sidgwick super-

telepathy on many different days, the subjects being in a hypnotic state and the hypnotizer, G. A. Smith, acting as agent. Most of the experiments were for the transference of numbers, the agent drawing from a bag one of 81 counters numbered 10 to 90 and gazing at it out of view of the subject. A number of hypnotized persons had no success, but four seemed to have telepathic power in that state. A Miss B. succeeded amazingly. Out of the following numbers drawn from the bag, 16, 67, 18, 37, 71, 66, 62, 50, 84, 15, 88, 15, she got all but three correctly and without any fumbling in the process, in all other three cases getting one of the figures correctly. Another

hypnotized subject at times had little success, but twice accomplished almost as remarkable a result as Miss B.

In 1890, Baron von Schrenck-Notzing, M.D., had a series of experiments with a number of subjects, which he summarizes in *Proceedings* of the Society for Psychical Research, Part 18. From the description of precautions taken, one would suppose that there was no chance for deception. The experiments were in the way of drawings which are reproduced here. Here the originals are marked O and the responses of the percipients marked R—where more than one attempt was made, they are marked R(a), R(b), and so forth, in experiments 10 to 14 inclusive, and in experiment 16. Despite the flat failure of 11, and the partial failure of 15, the set of seven experiments presents correspondences certainly vastly beyond the expectation of chance.

Miss Verrall, now Mrs. Salter and editor of the Society for Psychical Research *Journal*, in 1915 reported experiments with Miss K. Tipping, one of which is of curious interest. She gazed steadily at a black cat made of velvet, with the title beneath it, "A Black Cat." Miss Tipping visualized the face of a man, and made a rude drawing, which, together with the figure of the cat, is reproduced on this page. The man's hair spreads out very oddly on both sides of his head, much as the cat's ears oddly stand out. But, moreover, she wrote under the drawing "c—t", the first and last letters of the word cat.



TWO MORE INTERESTING TESTS

The experimenter gazed at the peculiar dog-eared cat made of velvet. The recipient made the possibly analogous sketch on the left, and got the letters "c-t"

DR. GARDNER MURPHY

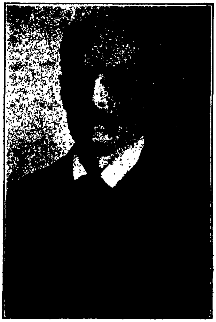
Two reports of the apparently telepathic work of Professor Gilbert Murray have been published in the *Proceedings* of the Society for Psychical Research (London). The conditions, briefly, were these: Prof. Murray goes into another room "out of earshot," and someone in the company selects a test and tells it to the others in order that all may fix their minds upon it; Professor Murray is summoned and gives his impressions. Some of the tests were quite complex, such as the invention of an anecdote with names of particular persons, places and acts included, so that it would not be supposed that there was one chance in thousands of a correct guess, even though the percipient was in physical contact with the selected agent. How could muscle-reading give knowledge that the agent was thinking of the game Badminton being played in Bogota, one of the players being a Mr. S——, and one person present Lord Murray—the whole incident being an invented one?

THERE were 505 experiments before 1916, which the accomplished Miss Verrall analyzed. She found the following percentages (omitting 68 cases where no impression was received): successes, 38.2; partial successes, 32.3; failures, 29.5.

Generally, Mrs. Toynbee, a daughter of Professor Murray, acted as agent, or ostensible sender of the mental messages, and she has always produced the largest percentage of correct results, a fact in accordance with the principle that a peculiar *rapport* exists between certain pairs of people. It is difficult to suppose that a man of such distinction as Professor Murray, one who appears, moreover, to be considerably embarrassed at his notoriety for "psychic" power, should lend himself to deceit and should actually be in collusion with his daughter, yet this has been suggested, and it is well that another series of experiments has been published in which many persons acted as agents, even though the average of their success was not so great. This series numbered 236 experiments and the learned and conservative Mrs. Henry Sidgwick, who drew up the report, estimates the percentages as follows: successes, 36; partial successes, 23.3; failures, 40.7.

Altogether six members of Professor Murray's family acted as agents in this second series in 167 of the tests, while 30 other persons acted in the remaining 69 experiments, and the experiments were held in several different houses. It will hardly be believed that 36 persons, even though most of them were acquaintances, were *in* collusion *to* deceive each other and the world. And it does seem strange, if such persons and so many should not have known how important it was to speak so that no sound could reach the room where the percipient waited. I do however, emphatically think that there should be a series of tests arranged in writing only, so that there can be no question of hyperesthesia or abnormally acute perception, incredible as such a theory may seem.

Instead of choosing the most striking successes, I will give one made in September, 1916, wherein Mr. Miller acted as agent. It will be understood that the language of the test was complete before the response began, and that it is only for economy of space that I have broken up the substance of Murray's response and interpolated its parts within parentheses after the relevant parts of the pre-



PROF. GILBERT MURRAY

One of the world's best telepathists, he is a famous Greek scholar at Oxford

viously arranged form of words constituting the test. In parts of the experiment, Murray said nothing relevant to the part of the test immediately preceding.

Mr. Millor acted as agent and independently chose his tests five times, each time selecting some public meeting which had occurred, but not giving any previous notice that the subjects would all be of this or any class.

> 62. "I'm thinking of myself addressing a strike meeting." ("This is you yourself waving your arms [the fact that Mr. Millor was accustomed to wave his arms when speaking may have been known to Murray] and making a speech, and I suppose it is addressing a strike meeting") "outside Baliol [Oxford] at the Martyr's Memorial." ("I guess *outside* the mill at Chipping Norton.")

IN Paris, M. Warcollier has been doing notable and significant work in the way of telepathic experimentation for some years.

Dr. Gardner Murphy of Columbia University has spent much time experimenting for telepathy, and most of his subjects have yielded no evidential results, but it is quite otherwise with several of them. A particular experiment, conducted by him and Professors Gault and English illustrates the same fact, that good subjects are rare. The three gave notice to radio audiences that they were concentrating on something of a class, as a figure between one and 1000, a pain at some point on the hands or arms, et cetera. Out of 2500 reports sent in, only two showed results presenting any problem, but one of these presented a mighty one, for it showed so many successes and to such a degree that it is conservative to say that the chance of getting them in combination was not one in a hundred million.

The latest American experimental work has just been published by the Boston Society for Psychic Research and has attracted considerable attention from men of scientific bent. I quote from Dr. Murphy's description of the methods and the results.

"My successor at Harvard, Dr. G. H. Estabrooks, has improved on my methods in several striking respects. First, he has chosen his subjects in a radically different manner. Instead of selecting only a few, he has rejected only those who could not or would not cooperate, has taken graduate and undergraduate students by the dozens, and many other individuals. He has found methods of winning the confidence of his subject and of interesting him in his task. The simple expedient of promising an exhibition of card tricks proved to be successful bait with a large number of undergraduate students who were taken just as they came.

"In view of the fact that his work is soon to be published, I can refer to his work only in a very general way. He made use of two rooms in the Harvard laboratory which are separated by a heavy double door. An automatic timing apparatus gives a signal upon which he cuts a pack of cards and concentrates intensely upon the card chosen. The same instrument causes the signal to be given in the other room in which sits the receiver. The latter writes down instantly and without allowing himself to "think," the name or number, and the suit of a card.

"The results, which will soon be available for you in tabular form, show not only that great statistical difficulties would occur in applying the usual explanation in terms of chance, but that the results are extraordinarily consistent. The best results are in the first five experiments with a given subject, the next best are in the next five, and at about the fifteenth experiment the results drop to what we should expect from chance. Statistical measure of chance is applied to color, suit and number. Consistently, the result from colors, that is the choice of red or black, is enormously better than the result from the suit or from the designation of the individual cards."

DR. ESTABROOKS be it understood, is very modest and tentative in his conclusions, and is still pursuing his experiments, which tend to show that, while marked telepathic power belongs only to the few, there is a trace of it in most people, which may be rendered perceptible by a mass of experiments properly conducted.

Laboratory experimenters are racking their brains to devise methods which will be proof against suspicion that the agent does not give even unconscious signs which the percipient cannot subconsciously interpret by even hyperesthetic (that is, abnormally acute) exercise of a bodily sense. With some subjects and by some experimenters, tests have been so complex and conditions apparently so strict that a "normal" solution seems to require that the agent unconsciously whispered words through his nose and the percipient hyperesthetically heard them, his hyperesthesia taking the peculiar form of unawareness that he heard anything at all.

THE EXPERIMENTS AT HARVARD

RECEIVING THE THOUGHT

In a separate room the receiver sits and at once w the impression when the signal is given by an elec

Courtesy of The Illustrated London News

The June 29th Solar Eclipse In England

Two interesting phases of solar eclipses are graphically illustrated in the artist's drawing reproduced above. The first is that of Bailey's Beads, made possible by light passing through the valleys between the lunar mountains. Irradiation gives the naked-eye effect shown. The second is a photographic phenomenon wherein multiple images of the partially eclipsed sun are projected on the ground by the "pin-hole" camera effect mentioned.

All photographs by Underwood and Underwood

EQUIPPED WITH A RADIO SET

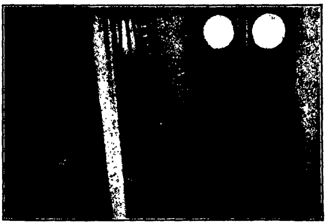
This is the trim bedroom of Monsieur Louvet's home on wheels, its seven windows resembling the portholes of a ship

LOOKING DOWN THE CORRIDOR

As in a French railroad coach, the long corridor runs along one side of the caravan, and the various rooms open off from it

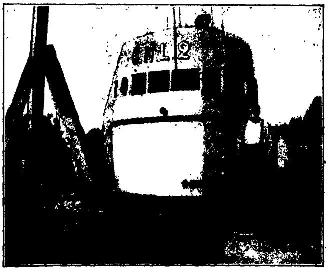
THE DINING ROOM AND GALLEY

In the background is a portable phonograph, also a portable typewriter. Everything is shipshape and nothing is crowded



THERE IS EVEN A BATHTUB

The tub fits the inside contours of the body of the caravan and there is running water, cold and hot (from the radiator)



THE CARAVAN AND ITS BUILDER

REAR VIEW: *The house is 36 feet long and was constructed—furniture, accessories and all—by the owner, within one year*

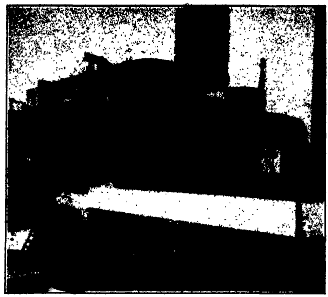
A Frenchman's Motor Caravan, a Home on Wheels

Monsieur Louvet, resident of Nice in southern France, decided recently to "see France first," and to see it with all the comforts of home. No sooner said, than he proceeded to construct a four-room house on wheels, and the reader of this issue of the SCIENTIFIC AMERICAN may therefore think of Monsieur Louvet at this very moment driving leisurely over the superlative highways and byways of his native France, or stopping to rest at some chosen spot. What a care-free life! No camp to make, for the camp is always with one and all made up. No baggage to worry about, for everything is carried aboard the caravan. Next year Monsieur Louvet plans to do the same thing in America, where he will, however, find things a little different. Although motor camping in this country has almost become a profession, there are relatively few large motor caravans of the kind he is using. In some sections where the roads are comparable in quality with those of France, there is a bit too much traffic for comfort, while in other parts of the country that might appeal most strongly to the motor camper, a 5000-pound vehicle may prove too heavy for extrication from the many mudholes. We advise Monsieur Louvet to replace his small tires with double-tread "balloons." And even then he may wish at times for caterpillar traction belts.

All Photographs courtesy New York Edison Company

NEW YORK'S GREATEST GENERATING STATION

When completed this station will be nearly eleven hundred feet long and will have a capacity of one million kilowatts

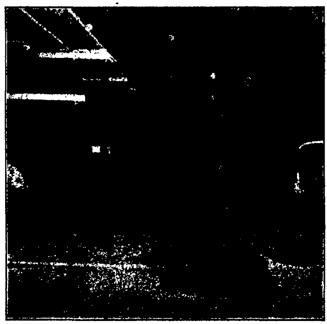


CENTRIFUGAL CINDER CATCHERS

The gases pass from the boiler through a preheater, a wet dust catcher, and thence to centrifugal dust catchers on the roof

ONE OF THE GREAT FANS

Huge fans, such as the one illustrated, are used to force air into the preheaters and from there into the hot air downtakes

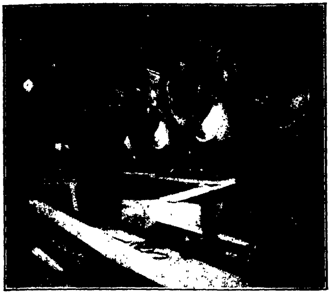


PIPES FOR PULVERIZED FUEL

It is through these pipes that the pulverized fuel is fed to the boilers. The coal used is previously pulverized in a mill house

Power Plant to Generate 1,000,000 Kilowatts

The East River Generating Station of the New York Edison Company was designed by Thomas E. Murray, Inc., associated with the engineers of the owning company. This station will supply 25-cycle current at 11,400 volts to the Edison System, and will also provide means of "tying in" the Edison 25-cycle system with the United Electric Light and Power Company and the Brooklyn Edison Company's 60-cycle systems, through large frequency changers. When completed, the plant will occupy an area 1092 feet long by 206 feet wide and will have a capacity of approximately 1,000,000 kilowatts. The present building is approximately 354 feet long by 206 feet wide. The property affords suitable accommodations in the main structure for nine steam turbines; the first two, already installed, have a capacity of 60,000 kilowatts each. Succeeding units will probably be of larger size, as 150,000 kilowatt single-shaft units can be accommodated, bringing the ultimate capacity of the plant to over one million kilowatts. There is also adequate provision for a mill house for pulverizing the coal and for sufficient coal storage. We have already dealt with the generating units and their accessories in the issue for November, 1926. Some years ago, Thomas E. Murray, in an endeavor to increase the steam-producing capacity of power-house boilers and decrease the cost of furnace maintenance, conceived the idea of a completely water-cooled boiler-furnace wall of improved design, completely eliminating the use of fire brick and refractories with their attendant rapid deterioration and high repair cost. This design has been given a thorough test at the Hell Gate Station, with most satisfactory results and, with subsequent improvements, now forms the basis of a



MOTOR-DRIVEN COAL PUMPS

These are motor-driven pumps which force the pulverized coal through the various pipes and burners and into the boilers

THE WATER-TUBE WALLS OF THE BOILER

The furnace wall is water-cooled so that the use of fire brick and refractories is done away with, thus avoiding deterioration

INSULATING THE OUTSIDE OF THE BOILER

To keep in the heat, the outside of the water-tube walls of the huge boiler must be insulated by fire-resisting substances

THE BOILER COMPLETELY COVERED

Insulation is complete and the boiler is ready for "blowing-in" at a pressure of three hundred and seventy-five pounds

unique and epoch-making steam-generating unit of enormously increased capacity, low maintenance and labor costs and high efficiency. The boilers have a normal commercial rating of 50,000 pounds of steam per hour, but with these improvements they can be operated at continuous overloads, so as to produce 250,000 pounds of steam per hour—something like 500 percent of their rating. They are of the cross-drum type with the boiler tubes inclined at about 15 degrees to the horizontal—the unique feature being the enormous combustion chamber, which is entirely enclosed in water-cooled walls. The boilers are provided with steam superheaters, and preheaters supply hot air for combustion, the hot air being injected with the powdered coal. Draft requirements are provided by means of forced draft through the air preheaters and induced draft to the stack. The flue gases are washed in a wet washer or cinder catcher and then passed through enormous centrifugal cyclones, which catch the fine dust before the flue gases are finally delivered to the colossal stacks 375 feet high by 22 feet in diameter. There will be seven of these in the completed station. Disposal of the dust and ashes is provided for through a hydraulic flushing system. The pulverized coal received from the grinders in the mill house is forced by air pressure through transorting pipes across the connecting bridge into the individual bins of the boiler house, located above each boiler. From here it is picked up by the feeders and, with the compressed air from the primary air duct, the current of powdered fuel is forced into the furnace through the burners. The small amount of slag falls between the tubes forming the water screen located at the bottom of the furnace, and is precipitated into the ash pit, to be finally drawn out into the ash-discharge conduit. The gases resulting from combustion pass out of the boiler through the uptake, into an air preheater and into the wet type primary dust catcher. From this point the gases pass through the induced-draft fans to the secondary dust catchers or centrifugal cyclones, located on the roof of the boiler house. From here the gases pass into the main flue and then into the stack.

The Month In Medical Science

A Review and Commentary on Progress in the Medical and Surgical Field

By MORRIS FISHBEIN, M. D.
Editor of the Journal of the American Medical Association *and of* Hygeia

A Family with Low Blood Pressure

DR. JOHN D. GARVIN of Pittsburgh has recently reported six cases of low blood pressure in one family. The family is characterized by extreme activity, efficiency, hard work and splendid physique and is noteworthy for its longevity. Nevertheless, the blood pressures were very close to 100 in all cases; the highest recorded was 108, with the diastolic blood pressure varying from 66 to 70.

More and more physiciai are coming to attach little significance to relatively low blood pressure, provided the patient does not have other signs or symptoms of importance. The conviction is increasing that high or low blood pressure may frequently be an hereditary phenomenon. Much more significance, however, is attached to high blood pressure from the standpoint of its relationship to disease.

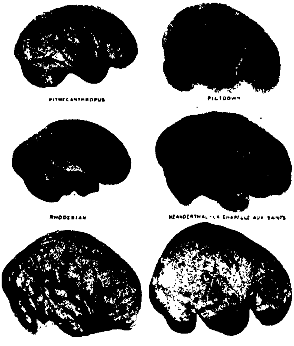
The Brains of Prehistoric Men

UNQUESTIONABLY the brains of men have been modified as they have progressed from the earliest time to the present. Recently Dr. Frederick Tilney of New York has made a study of the psychologic foundations of human progress, comparing the brain capacity and brain structures of the earliest man with those of the anthropoid apes and with modern men. It is generally well known to scientific readers that the skulls of *Pithecanthropus erectus*, Rhodesian, Predmost, Piltdown, Neanderthal and *Homo sapiens* represent varying stages in human progress.

Dr. Tilney finds that the brain of the Pithecanthropus, to which an antiquity of not less than 500,000 years is assigned, is of a much higher type than that of any of the great apes. This species has been called the "ape man" of Java and has been popularly referred to as the "missing link." Its frontal lobe is larger than that of the gorilla. The left lobe of the Javan man is slightly larger than the right, which Dr. Tilney believes indicates unidexterity. On the other hand, as compared with the brains of modern races, that of the Pithecanthropus resembles the brain of a three-year-old child.

Apparently the early ape man was capable of some advantageous reasoning, was right handed and had probably learned to speak. The means of communication are of first importance in the foundation of human knowledge.

The Piltdown skull has a volume about that of the gorilla, but much below that of the average adult human brain of modern races. The volume of the gorilla brain is 57 percent of that of the Javan man, and that of the Javan man 72 percent of that of the Piltdown. Dr. Tilney believes that this definitely denotes a more rapid expansion of the brain in the direction of the higher human standard, once the limits of the ape state were passed.



PREHISTORIC AND MODERN BRAINS

Comparison of the endocranial casts of the various races of prehistoric men as indicated, and of Homo sapiens

Apparently the Dawn Man lived in a community of considerable size and was capable of performing skilled acts. Apparently he was dependent for his livelihood on game. He used his implements only for food and for protection, but did not use them for cultivating the soil, for the production of clothes, or for the construction of permanent dwellings.

Neanderthal man made definite advances in human progress. He was a skilled artisan and flint-worker. He had command of fire; he buried his dead with ceremonial rites, which indicates a belief in a future existence. He seems to have had many of the attributes of higher man. His brain shows a still further expansion in all its major divisions. Nevertheless, his frontal lobes still have anthropoid tendencies, as shown by the projecting eye sockets, the low receding brow, and the broad nasal openings. Thus he had a definitely gorilla-like appearance.

As the frontal lobes of the brain enlarge, the orbital plates flatten, the enlargement of the frontal lobe having to do with the appearance of a higher intelligence. The cerebrum of man is that portion which gives him the capacity to develop, inculcate and transmit cultural activities. Man has grown in humanity as his brain has expanded. The outline of this development of the brain made by Dr. Tilney and published in the *Archives of Neurology and Psychiatry* is a highly technical account but is so logically developed as to lead definitely to the view that the frontal and prefrontal regions of the brain are of the greatest importance in differentiating man from the lower species. In the process of evolution they have developed progressively from the earliest Pleistocene epoch. Dr. Tilney believes that the human cerebrum is not yet a finished product. "Its evolutionary history," he says, "does not support this view, but makes it appear far more probable that the brain of modern man represents some intermediate stage in the ultimate development of the master organ of life."

Physical Defects In a Thousand Children

DR. WILLIAM R. P. EMERSON, professor of diseases of children in Tufts College Medical School in Boston, has recently tabulated the defects found in a thousand children. They included three rather distinctive social groups—the first, 245 dependent children in a charitable home; the second,

357 children seen in a clinic; the third, 398 children from well-to-do families who were observed in private practice.

It was found in this study, as compared with a previous investigation made in 1921, that the care of the teeth has made great progress during recent years, particularly among the well-to-do. However, the care of the teeth is also receiving increasing attention among the middle class and among the poor, since the teeth were found to be much better in general in the children examined at this time as compared with the thousand studied six years ago.

The investigation revealed from four to six physical defects in each child, including inflammations of various types, bad posture or physical abnormalities. About 50 percent of the disturbances were associated with the nose and throat, and about 30 percent of them were bad posture. The well-to-do families averaged 4.6 physical defects of all kinds and 1.8 due to nose and throat defects; the poor children, 5.2 physical defects of all kinds, and 2.5 due to nose and throat defects; the middle class, 6.8 defects of all kinds with 3.5 due to nose and throat defects.

Medical Research on Mummies

DR. ARNOLD SACK of Heidelberg recently reported in the *Munchener Medizinische Wochenschrift* the results of examinations made of Egyptian mummies with a view to determining the diseases from which they may have died. A mummy of the nineteenth dynasty had a typical clubfoot. Many of the mummies were found with fractures of the bones or with relics of fractures, sometimes held in place with artfully contrived splints.

Stones were found in the bladder of mummies dating back to periods preceding the first dynasty. Kidney stones were found and also a case of tuberculosis of the spine. Ulcers with cancerous changes were observed, as were almost every type of condition now recognized by the modern science of pathology.

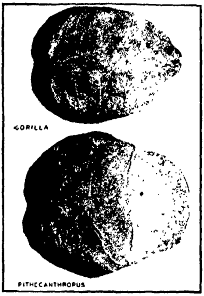
It is interesting to know that the teeth of the mummies were in general good, particularly in the poor population, but that the teeth of the kings were badly decayed in many instances and this applied as well to the teeth in 500 bodies of Egyptians of the highest class.

Students of the history of syphilis are divided into two groups, one of which believes that this disease existed since the earliest times, whereas the other is convinced that its first appearance in Europe dates from the discovery of America. Changes indicative of this disease were not found in the mummies, although 30,000 bodies were investigated.

Life Expectancy

IT is rather well established that the life expectancy of the individual has increased from 35 years in 1825 to 55 years in 1925. In this connection it is interesting to cogitate on the life expectancy of individuals in the earliest times. Geologists, archeologists and paleontologists estimate the age of the world varying from one hundred thousand to five hundred thousand or millions of years. Relics of ancient man have been studied with a view to determining his age. Apparently few men died of old age in early times. Indeed, the best evidence available indicates that early man seldom lived to 30 years of age. The exigencies of human existence in the savage state were such as to bring about an early demise.

Professor Todd of the department of anatomy of Western Reserve University of Cleveland has made a study of ancient bones with a view to determing this point. It is known, for example, that the epiphysis of the bones continues to form until some 30 years of age, and that sutures between bones ossify and close up from 30 to 45. The bones of the very old have other marks that aid a decision. Regardless of the patriarchs referred to even in the Bible, there is no reason to believe that ancient man lived very long. Modern knowledge and the conditions associated with modern civilization have added certainly 25 years to the average existence. With us today, sexagenarians are common and octogenarians are not infrequent.



ANOTHER COMPARISON

These are endocranial casts of the superior surfaces of the brains of a gorilla and of Pithecanthropus erectus

Skin Eruption from Linseed Oil

AN industrial physician who worked for many years in the paint industry noticed that skin disease was quite frequent among workers in the linseed-oil mill. These people had areas on the hands and feet which were frequently subject to itching and burning. In an investigation of this matter in the entire linseed-oil industry, it became clear that such cases appear in hundreds among such workers. The seeds from South America are more irritating than those from Canada or the northwest states, and those from India are even more irritating. The eruptions are usually on the forearms and hands, but appear occasionally on the neck, shoulders, chest and upper back. When the worker discontinues his work for three or four days the irritation promptly disappears.

In many instances the eruption followed the wiping of the oil and linseed meal from the hands and forearms with burlap, which is itself rough and irritating and frequently contaminated with infection.

Another investigator was convinced that the inflammation was caused chiefly by the dust from the flaxseed. He stated that he had seen 400 cases in the mill in which he had worked for a period of five years.

It is said that blonds suffer more with this condition than do people of darker complexion. A study of the appearance of this type of diseases in various mills leads to the definite opinion that contamination with the irritating substances produces the eruption, although the exact nature of the irritating substance is not yet known.

Milk from Stall-Fed Cows

MILK supplied by dairies in various parts of the United States differs as to its content of vitamins. Some of the milk comes from cows that are stall-fed the year 'round. The milk from pasture-fed animals has been reported by most investigators to be richer in vitamins than that from animals without access to pastures. Dr. Florence L. MacLeod of New York has made a study of the value of the milk of the pasture-fed cow as compared with that of the stall-fed cow, particularly as it relates to the content of vitamin C, the vitamin that is concerned with the prevention of scurvy. Apparently the ensilage, which is the principal source of the antiscurvy vitamin in the food of stall-fed cows, contains a considerable amount of this substance.

Dr. MacLeod's investigations revealed the fact that stall-fed cows that are given a well balanced, uniform diet throughout the year provide a milk which does not vary from season to season in the antiscurvy vitamin. In this connection, it is interesting to note that attempts are already being made to produce vitamins in milk by means of irradiation with ultra-violet rays.

Ice That Melts To A Gas

As A Refrigerant, Solid Carbon Dioxide Offers Many Advantages To Various Industries

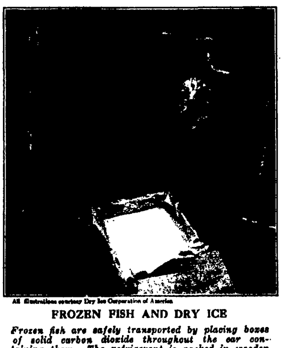
By D. H. KILLEFFER

CAN you imagine obtaining cold from a moth ball? Probably not, and even if you could imagine such a thing, the penetrating odor of naphthalene would certainly not appeal to your esthetic sense as a thing to be lightly mixed with food. Yet in a way, exactly the same thing that happens to a moth ball among the blankets in summer, occurs to the newest of portable refrigerants, solid carbon dioxide, when it is at work making cold. A few things have the valuable property of evaporating directly from a solid crystalline mass to a gas and as every student of physics knows, evaporation absorbs heat, which is merely a correct way of saying that it produces cold. Naphthalene and camphor can pass from a solid to a gas without becoming a liquid in the meantime, or leaving any residue. This property of evaporation makes them valuable for driving away the insects that would devour our winter coats and blankets if given a chance. If these chemicals evaporated faster and were less odorous they might very well be used in the ice box.

SOLID carbon dioxide, produced by mechanically freezing the same gas which imparts "fizz" to soda water, evaporates rapidly enough from a solid mass to a gas to be a useful cold producer. Unlike moth balls and camphor, it possesses no odor and produces no harmful effect on foods. Pound for pound it absorbs much more heat in evaporating than ordinary ice does in melting and there is no water or other liquid to be drained away from the cooled space.

One must not confuse the subject of this discussion, which is to all intents and purposes a new kind of ice, with the numerous mechanical refrigerators for home use now on the market, which are no more than working miniatures of ice-making machines and cannot be removed from their source of power. Solid carbon dioxide is essentially portable and while it requires special handling to bring out its best efficiency, it is merely a very cold kind of ice.

This convenient new refrigerant is the latest thing to send a shiver of apprehension up the spine of the refrigerating industry. The tremor along that same spine caused by the general introduction of fool-proof mechanical refrigerators into the family ice box has hardly died out when another, which may be even more serious, is started merrily on its way. Of course, the icemakers quieted the first fearful chill with the more or less coolly comforting thought that ice could be carried from place to place much more easily than a mechanical contrivance for making it, so that a large and growing part of their business, refrigeration of perishables in transit, would not be bothered. But that cannot be said of solid carbon dioxide, which is in most respects just like ordinary ice. That is a different story. How different, time alone will reveal, but the facts of the first chapter certainly intrigue one's interest in the history that is still to be made.



All illustrations courtesy Dry Ice Corporation of America

FROZEN FISH AND DRY ICE

Frozen fish are safely transported by placing boxes of solid carbon dioxide throughout the car containing them. The refrigerant is packed in wooden boxes quite like those containing the fish

Solid carbon dioxide, the laboratory curiosity shown to students of physics and chemistry for more than half a century, is difficult to consider new, but this plaything of the laboratory and the lecture table has now gone so far as to threaten a revolution in methods of long-distance transportation of foodstuffs. One is not inclined to attach any great significance to the laboratory stunt of blowing liquid carbon dioxide into a canvas bag to form a very cold snow, with which liquid mercury may be frozen to a solid hammer. But when a similarly simple operation is applied economically in industry and tons of this snow are made and used every day; when by its use so perishable a commodity as ice cream can be economically transported from New York and Philadelphia to the warm climate of Cuba in such large quantities as to bring the threat of an embargo on its import; and when carloads of frozen fish can be shipped by rail on a five days' journey without re-icing and without thawing, the situation becomes essentially different. One must recognize that the elements of an industrial revolution are present. However, just how extensive this revolution may be, what fields it may ultimately touch, and what economic structures it may seriously affect or overthrow, one can only guess.

AN ancient recipe for rabbit stew began with the wise injunction to catch the rabbit first. That is a proper beginning for a description of the making of solid carbon dioxide, for, although there is no other single waste of industry that is comparable to the huge tonnage of carbon dioxide daily vented from our chimneys, there are few more difficult to "catch." The burning of any material containing carbon, with plenty of air, produces carbon dioxide, and, after properly washing out the soot and impurities of ordinary flue gas with water, the carbon dioxide may be absorbed in a cold solution of sodium or potassium carbonate. Heating of this solution under pressure releases the pure gas, which can then be liquefied by cooling and compressing to 1100 or so pounds per square inch.

The difficult part of this is that the process requires more energy by nearly 200 percent than can be obtained from the coke that is burned to produce the carbon dioxide. In other words, the burning of coke produces three times as much carbon dioxide as the heat generated by it will serve to compress and liquefy. That, of course, is the reason why power plants cannot now recover this increasingly valuable waste from their flues.

Having the liquid, there is no trouble about getting the solid. All one needs

to do is to allow the liquid to escape through a small orifice and catch the snow as it is formed. For longer than anyone cares to remember, it has been a standard demonstration in most classes of chemistry and physics to invert a cylinder of carbon dioxide and allow the liquid to escape through the opened valve into a canvas bag. Afterward it is found that the bag contains a very cold snow of pure carbon dioxide. In present commercial practice, the principle employed is exactly the same, with the exception that the snow produced is compressed into solid blocks by pressures of 500 to 800 pounds per square inch. Refinements of the operation increase the yields of solid but there is no essential difference.

THAT briefly is the story of making solid carbon dioxide, which has often intrigued the fancy of inventors. We must now consider the reason why it now is successfully used here after so many failures abroad. The growing necessity for transporting perishable foodstuffs over long distances, requiring several days by rail, has led to the development, in the United States, of extensive systems of refrigerator cars, based naturally upon water ice, and along with this development has come the further need for frequent re-icing stations for cars en route, to assure the delivery of their cargoes in first-class condition. No comparable systems have been developed abroad to furnish ready outlets for portable refrigeration and the failure of foreign inventors to recognize the specialized peculiarities of solid carbon dioxide in use foredoomed their attempts to commercialize it. With a huge potential market for a thing of the kind already in existence, and with methods of application developed to the point of making competition possible with the only existing portable refrigerant, frozen water, the possibilities of the new industry are very great.

The value of the new refrigerant depends primarily upon two important facts: solid carbon dioxide evaporates directly from a solid to a dry gas and in so doing it absorbs an amount of heat nearly double that absorbed by the same weight of ice in melting. By taking full advantage of these two considerations in its use, one pound of solid carbon dioxide can be made to serve the same purpose as 15 pounds of ice in producing temperatures below freezing. Since its cost on the present limited scale of production is only about ten times that of ice, there is reason to expect much from it as the expansion of its manufacture brings its price down. Probably its greatest advantage is in the fact that a dry gas is produced direct and there is no liquid, carrying potential cooling capacity with it, to be drained away. The second great advantage is in the high heat-absorbing capacity of carbon dioxide in passing from the solid to the gaseous state—carbon dioxide absorbs approximately 275 British thermal units per pound in passing from the pressed cake to gas at 32 degrees, Fahrenheit, in contrast to ice which absorbs only 144 British thermal units per pound in melting at 32 degrees, Fahrenheit.

MAILING-PACKAGES FOR DRY ICE

Blocks of solid carbon dioxide are cut on ordinary wood saws to convenient sizes for inclusion in mailing packages containing ice cream and other frozen delicacies. The solidified gas will keep ice cream frozen for several days in the mails

THE evaporation of the solid carbon dioxide directly to a gas has a peculiar value, of which advantage is taken in refrigeration practice. The atmosphere of the refrigerated space is constantly replaced by fresh, pure, cold, dry carbon-dioxide gas, which is quite harmless to products stored in it and is indeed considered to be an actual preservative of many foodstuffs. Each pound of snow evaporated yields about eight cubic feet of gas, which is allowed to fill the refrigerated space and to overflow from vents situated as near its top as practicable. In this way any accumulation of odors in the stale air which would be confined within an ordinary refrigerator is avoided, and in addition, the heat leaking through the walls is absorbed and vented along with the gas overflow. By venting the heat leakage in this manner, it is unnecessary for the refrigerant to absorb it and thus the amount of evaporation needed to keep a cold space at the desired low temperature is only that required to keep up a flow of gas through the vents large enough to carry the heat leakage with it, the gas

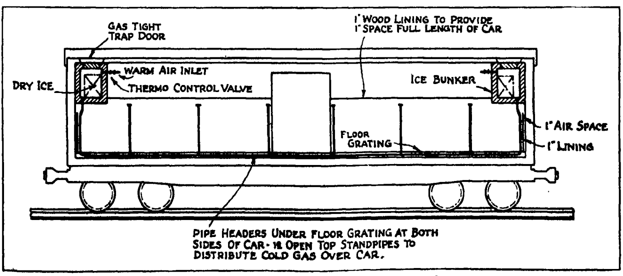


DIAGRAM OF ICING ARRANGEMENT OF REFRIGERATOR CARS

This drawing illustrates the method of equipping a refrigerator car for the use of dry ice where the cargo would be damaged by freezing. The cold CO_2 gas generated by the melting of the solid is conducted through the cargo in pipes, and is allowed to fall over the perishables. The bottom of the car is sealed and gas is allowed to escape only through traps in the top of the car. No other ventilation is permitted, and thus the circulation of cold gas is maintained

passing out at the maximum temperature of the space. In other words, the incoming heat is carried out at the highest possible temperature, which may be decidedly higher (150 degrees, Fahrenheit or more) than the temperature of the evaporating solid itself. The case of water ice is quite different, for the liquid water leaving the refrigerator is at or near the temperature of the melting ice itself and hence must remove heat at the lowest feasible temperature differential, and in addition there is always the accumulation of undesirable odors in the necessarily confined air.

IN spite of its very low temperature —the internal temperature of a block of carbon-dioxide snow in an atmosphere of the same gas is about 112 degrees below zero, Fahrenheit (80 degrees, Centigrade)—the product is remarkably long-lived under most practicable conditions. The explanation of this phenomenon of slow evaporation appears to be the presence within the cake itself of gas-filled voids making up about one fourth of its volume and the formation all around it of an insulating layer of cold gas. The heat conductivity of the somewhat porous block is very low as compared with a solid block such as one of water ice, and hence it is difficult for heat to penetrate it. The blanket of cold gas constantly surrounding the evaporating block prevents its contact with warm air, and possibly even its direct contact with a heat-conducting solid upon which it may rest, a situation quite different from that of water ice, which on account of convection currents is in constant contact with air much warmer than itself.

The very high heat-absorptive capacity of the evaporation of solid carbon dioxide to gas makes it especially fortunate that these natural forces can be utilized to make the process a slow one. While the temperature of evaporating solid carbon dioxide in an atmosphere of its own gas is -112 degrees, Fahrenheit, if the block is placed in air its temperature can be reduced still further to -139 degrees, Fahrenheit. This effect of reducing the vapor pressure of the carbon dioxide in the atmosphere surrounding the solid can be used to advantage where rapid cooling to very low temperatures is desired.

THE low temperature of evaporation of the carbon-dioxide snow provides a valuable factor of safety as compared with water ice, where low temperatures must be maintained, as in the transportation of frozen commodities. The necessity for using salt along with water ice to produce temperatures below the customary one of 50 degrees, Fahrenheit (10 degrees, Centigrade), not only involves additional labor but also reduces the overall efficiency of the refrigerant. With carbon-dioxide, temperatures as low as -40 degrees or -50 degrees, Fahrenheit may be attained with reasonable efficiency and at much higher efficiencies than freezing temperatures with ice and salt mixtures. Indeed, probably the most important field for carbon-dioxide ice is in those temperatures below the melting point of ice so often required in commerce, as in the transportation of frozen meats, fish, ice cream, et cetera, for its efficiency is much higher than that of water ice below 32 degrees, Fahrenheit. In all cases where freezing might be deleterious to the material to be cooled, the carbon-dioxide ice must be carefully insulated so that only the gas evolved (having a specific heat of approximately 0.2) comes into contact with the material and that even then it be diluted considerably with the warmer gas in the upper parts of the refrigerated space.

The most spectacular use of solid carbon dioxide, which is not at all competive with any other refrigerant, is the cooling of small parcels of ice cream in paper containers to be sent by express or mail or otherwise carried for considerable distances. The weight of the refrigerant is small, its rate of evaporation slow, the product of its cooling action is a harmless gas and not a more or less disagreeable liquid, the weight of container and necessary insulation is small, and it is capable of keeping the contents of the package cold for as much as 36 to 40 hours without difficulty. Its application to less than carload shipments of many commodities, obviating as it does the return of heavy empty containers and at the same time the necessity for reicing en route, has proved very economical. Cans of ice cream may be readily shipped with solid carbon dioxide packed around them in padded canvas bags, which are decidedly lighter than the heavy tubs required for ice and salt. This system is illustrated below.

THE evaporation of carbon dioxide to a dry gas not only makes feasible its use in paper or cardboard containers for small-lot shipments without the necessity of the return of empty tubs or barrels, but for carload freight it also reduces the maintenance cost on refrigerator car equipment. The depreciation of refrigerator cars in service is very rapid, largely because of the moist cold supplied by water ice and the brine drippings from ice bunkers which must be cared for. There is also the possibility that drip pipes may become clogged and water collect around the cargo, resulting in serious damage. There may, too, be some advantage in avoiding the drip of brine and ice water onto rails and ties, thus reducing corrosion and the cost of maintenance of way.

CONVENIENT PACKING OF ICE CREAM

Blocks of dry ice, packed in heavy padded canvas bags, together with cans of ice cream, make transportation simple

DRY ICE MANUFACTURING PLANT

Here are shown the evaporators and hydraulic presses for forming the blocks. Some finished dry ice is on the bench

BEFORE DREDGING

Swan Island, at Port of Portland, Oregon, before the dredging operations. To the right of the island is the original ship channel leading to the city. Swan Island for many years forced the main flow of the Willamette River into a narrow and crooked channel lying in the stretch of water between the island and the shore on the right. The Port Authorities possess some of the most powerful dredges in the world, and these had done much notable work in filling waste and swampy lands. They were used in dredging away the portion of the island to the left and forming a new chan-

ISLAND AS AIRPORT

In the original plans, it was decided to dredge away the island on one side, and deposit the material on the right-hand side. It was intended to use the island as a terminal site for freight, and there was some thought of constituting it as a free-port area. Subsequently, the inauguration of the coast-wise air mail, and the increasing general interest in aeronautics created a demand for an airport as part of the city's terminal facilities. The Port Authorities accordingly made the new Swan Island into an airport, which is shown on the illustration by the smooth surface, which is 6000 feet long by 1224 feet wide

Building an Airport With Dredges

Swan Island, at Portland, Oregon, has for many years forced the main flow of the Willamette River into a narrow and crooked channel, where marine disasters were frequent. As part of its general plan for improving the harbor at Portland and the approaches thereto, the Port Commission determined, some time ago, to remove the island and open a new, straight channel, using its powerful suction dredges for the purpose. As the plans were worked out, it developed that the entire island would not have to be removed. The commission's engineers decided to dredge away the island on the side away from the existing ship channel, pump the soil across it, and deposit it on the side adjoining the ship channel, thus literally turning it over into a new position in the stream. The new land was to be used as a freight terminal site. The recent inauguraton of the coastwise air mail created a demand for an airport as part of the city's terminal facilities. The mail, flying over the city, was compelled to land across the Columbia River at Vancouver, Washington, ten miles distant. This involved a delay of approximately 40 minutes in distribution of Portland letters. Swan Island, it appeared, would not be needed for some time as a terminal site and it was agreed by the commission and the aerial leaders of the commnity that it offered an ideal site for an airport. The airport will rise about five feet above the high water level of the river. It will be slightly over 6000 feet long by 1224 feet wide. Its longer axis directly parallels the prevailing winds at Portland. The projected causeway will permit construction of a 5000 foot runway at an angle of 45 degrees to this axis and this will parallel virtually all the other winds experienced there. Thus landing and take-off may be made directly into the wind at all times, in spite of the comparative narrowness of the airport. The airport will have a number of advantages. Among these are easy visibility from the air, even in thick weather, ease of access (there being no obstructions in the aerial approaches), and better meteorological conditions than at any other location in the Portland area. Also, it will be but one and a half miles from the city. Buildings and service arrangements on the island will be of the most approved types. Use of neon tubes for marking the boundaries of the field, and other highly modern appliances are under consideration. Six batteries of floodlights are planned to make the field available for use during the night hours. "We have plenty of money and will spend whatever is needed to make this a first-class field, available for use 24 hours every day," said J. H. Polhemus, chief engineer of the commission. The estimated cost of the airport is 1,250,000 dollars. In moving the island, about 30,000,000 cubic yards of material were handled by the four dredges operated by the Port Commission. The work occupied more than two years. Simultaneous dredging of the channel and building of the airport lowered the cost of each.

Sleepy Sickness

Epidemic Encephalitis, or Sleepy Sickness, is Apparently a New Disease Whose Unknown Cause is Being Sought by Science

By SIMON FLEXNER, M.D.
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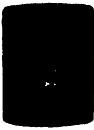
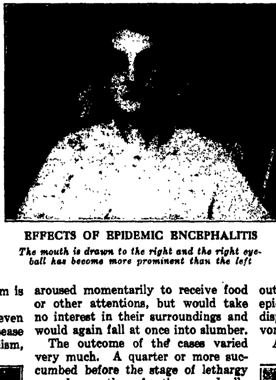


The Author

BEFORE the close of the war, in the late winter of 1918, a curious nervous disease appeared in England and France. Both countries were at the time suffering from food shortage, and the populations were therefore on a rationing system. In England for the first time canned, or as they are there called, "tinned" foods came into wide use. It was known that spoiled canned foods sometimes contain a peculiar poison of bacterial origin, which induces botulism in man, a severe and often fatal form of food poisoning attended by certain nervous symptoms, of which paralysis of the muscles of the eye forms a part.

THE cases of nervous disease which became exceedingly prevalent in the early months of 1918 were attended by paralysis of the muscles of the face, including those of the eye. In the absence, therefore, of previous experience with an epidemic disease of this character, the confusion of the disease with botulism is perhaps excusable.

But there was a second and even more striking attendant of the disease unknown in connection with botulism, namely an overpowering lethargy or tendency to sleepiness. The victims of the disease would fall asleep under extraordinary and most inconvenient circumstances—while in conversation or at table, as well as over daily tasks or lessons. This happened at the onset of the disease; as it progressed, the lethargy would become so profound as to keep the patients asleep for many consecutive days. While in this deep slumber, they could be aroused momentarily to receive food or other attentions, but would take no interest in their surroundings and would again fall at once into slumber.



EFFECTS OF EPIDEMIC ENCEPHALITIS
The mouth is drawn to the right and the right eyeball has become more prominent than the left

The outcome of the cases varied very much. A quarter or more succumbed before the stage of lethargy passed; another fraction gradually regained normal consciousness and were restored to health; another fraction recovered only partially, becoming victims of chronic disease of the nervous system, often of very serious character.

With the close of the war it became apparent that not only England and France, but other countries also had experienced this remarkable disease. Indeed, it was discovered that a Viennese doctor by the name of von Economo had published in 1917 a description of a series of cases coming under his observation, for which he had invented the name of "lethargic encephalitis," the word encephalitis meaning an inflammation of the brain, evidences of which had been observed in cases terminating fatally that had been examined *post mortem*.

The Viennese cases were readily identified as being identical with the English and French, and the view prevailed that the disease which was new to the western world probably had long existed in the East. This belief has not been upheld by precise studies carried on since then, and the view that the Viennese cases were the first to be observed is now no longer held, since it has become known that an even larger series had been observed in 1916 by Cruchet and others in the invalided French soldiers in the neighborhood of Bar le Duc.

THE first cases of the disease appeared in the United States a year later than they arose in England, or in 1919. Between 1919 and 1926, the disease spread widely throughout America and many hundreds, or even thousands, of cases occurred. Within this period, many cases arose in Europe and others were reported from Asia, China and Japan. In 1924, a severe epidemic outbreak raged in Japan, in which 7000 known cases with nearly 4000 deaths occurred. With the passage of time and the recognition of the tendency to mass outbreaks of the disease, the name epidemic encephalitis has practically displaced the earlier one applied by von Economo.

Another reason exists for the change

EFFECT ON THE SPINAL CORD
Microscopic section of the upper spinal cord in a case of epidemic encephalitis. A blood vessel is almost occluded by an abnormal collection of lymphocytes

DEGENERATED NERVE CELLS
Photomicrograph of the black substance of the brain, showing degenerated nerve cells invaded by phagocytes, a special variety of the leucocytes of the blood

in name. The first cases of the disease observed in all the countries involved were of the lethargic or sleepy character. It was the English who gave the name "sleepy sickness" to the affection, to distinguish it from the well-known African disease called "sleeping sickness." The two diseases are entirely distinct in origin: the African disease is caused by a parasite, a trypanosome, carried by the biting tsetse fly, and is visible under the microscope; while the microbic source or incitant of sleepy sickness is unknown.

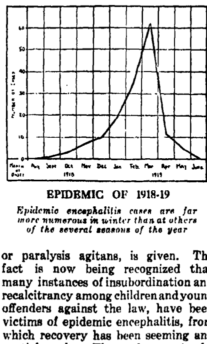
IN contradistinction to the sleepy cases, many cases of an opposite type have now come to be distinguished. Instead of the main symptom being lethargy, it is in this case overmuscular, sometimes overmental, activity. If the one class of cases is spoken of as hypokinetic, the other may be, as indeed it is, called hyperkinetic. Many hundreds of these hyperkinetic cases have been described. It is not difficult to account for both kinds of cases on the basis of what is known of the localization of function in the brain. According as the inflammation attacks chiefly one anatomic and physiologic region or another, there will result either lethargy or overaction. Sometimes both processes follow one another in patients in whom the inflammation is progressive, involving different parts of the brain in succession.

Now that a number of years have elapsed since the disease reached world-wide, or as we call it, pandemic extension, abundant opportunity has occurred not only to ascertain its toll as measured by death and recovery, but also the consequences as determined by its after effects. The mortality has ranged from 25 to nearly 60 percent, according to time, place, and the number of persons attacked. The highest recorded mortality seems to be that of the Japanese epidemic of 1924.

ANOTHER PHOTOMICROGRAPH

Cross-section of the brain, showing characteristic collection of lymphocytes about the small blood-vessels

A very serious aspect of the disease arises from the sequences or late effects. While the paralyzed muscles of the face usually recover their action, those of other parts of the body may not do so. But the paralytic residues of encephalitis are far fewer and are less severe than in poliomyelitis or infantile paralysis. The serious sequences are of another sort, namely as influencing the mental traits of the victims, to the extent of modifying profoundly their character, or of the kind which lead prematurely and frequently to that over-rigid state of the general muscular system to which the name of Parkinson's disease,



EPIDEMIC OF 1918-19

Epidemic encephalitis cases are far more numerous in winter than at others of the several seasons of the year

or paralysis agitans, is given. The fact is now being recognized that many instances of insubordination and recalcitrancy among children and young offenders against the law, have been victims of epidemic encephalitis, from which recovery has been seeming and partial only. The subsequent degenerative processes in the brain have led on the one hand to psychical states modifying character, and on the other hand to those pathological changes which lie at the bottom of the group of symptoms to which the name of Parkinson's disease is applied.

Our knowledge of epidemic diseases in general readily enables us to identify them with the diseases recorded in earlier medical or other writings. Their history is a long and sinister one. We can easily trace plague, cholera, influenza, smallpox into the remote past. With epidemic encephalitis the case is wholly different. We have not discovered in the written records of disease, descriptions with which it can be certainly identified. Certain kinds of nervous affections attend

SECTION OF BRAIN

Characteristic abnormal collection of lymphocytes in small vessels and in the substance of the brain tissue

other epidemic diseases, as influenza, meningitis, and smallpox. But these affections differ in symptoms and in pathology from the disease which since 1918-1919 has circumnavigated the globe and come to be called epidemic encephalitis. No one can of course assert that it is new in the history of the world; it may indeed have a local habitat not now known, but which future exploration may reveal.

THE exciting cause of this apparently new sort of epidemic disease is being sought assiduously by bacteriologists all over the world. Already on two or three occasions, premature announcement of its discovery has been made. That ultimately it will be discovered may well be predicted. It is already known that the microbe—for one cannot doubt that the disease has a parasitic origin—does not belong to the classes of organisms detectable by the means at present available to bacteriologists. But as these means are being constantly refined and made more effective and as microbes unknown a decade or two ago are by them now easily distinguished, it requires no undue faith to express the belief that the time is not far distant when the source of this severe disease may be determined.

A curious complication of this study has been the confusion of the virus of cold sores with the virus of epidemic encephalitis. The confusion arose from the strange fact that the cold-sore virus produces encephalitis in rabbits. The first efforts to induce epidemic encephalitis in laboratory animals seemed to be successful. But a condition so inoffensive as cold sores in man, when transferred to animals, may give rise to severe and even fatal effects.

Why Fly Without Radio?

When Lost at Sea, a Crippled Plane Without Wireless Has as Much Chance as a Mouse Among Cats

By ORRIN E. DUNLAP, JR.

TRANSATLANTIC airplane flights seem to come in eight-year cycles and always in the spring, because weather conditions are more favorable at that time for long oversea trips through the air. The year 1919 stirred up the daring of birdmen. A flock of them migrated in May and June of that year to the Grand Banks of Newfoundland. Two successfully winged their way to the other side of the ocean, but the majority met with adversity in preliminary tests or dropped into the sea.

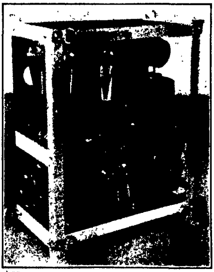
Eight years passed before another flock perched on flying fields in the United States and France ready to annihilate the distance between the Old and New Worlds when the weather man signaled that all was well in the air.

THE *American Legion*, piloted by Lieutenant-Commander Noel Davis and Lieutenant Stanton Wooster, was one of the first planes ready to leave for Paris in the spring of 1927. It carried the latest in radio equipment, including a short wave transmitter, the signals from which were heard with good intensity in Times Square, New York City, when the plane was cruising over Langley Field in Virginia. One morning it went up for a final test. It was heavily burdened. There was difficulty in rising. It fluttered like a duck shot in mid-air and plunged into a swamp. The two gallant fliers were killed.

The radio set which was designed to radiate the glory of aviation from the expanse over the Atlantic came to grief in a muddy pool, before it even had a chance to send out a plea for help. In fact radio was not needed in this emergency. Men saw the plane drop. They rushed to the scene of the accident. But, had the plane surrendered itself to the mercy of the Atlantic, radio's role might have been entirely different than it was in the Virginia mud.

Several weeks later a flash from Europe announced that the ace of aces, Captain Charles Nungesser, who had shot down 47 enemy planes during the World War, and Captain Francois Coli, had hopped off from Le Bourget flying field and were on their way to New York in the *White Bird*, with no radio on board. It had been discarded to save weight. The plane was last seen as it passed over Ireland headed out over the Atlantic, where, as one noted aviator remarked, "without radio they had as much chance when they dropped to the water as a mouse among cats."

It was on May 8 that Nungesser, Coli and an array of mechanics were up before daybreak. Some hundred blue-coated poilus in steel helmets and with bayonets fixed patrolled the field. Lightning flared. A downpour dampened Paris and vicinity, but not the spirits of the airmen. They were aware that the storm was local and that in the distance the sky was clear. The clouds disappeared. The day dawned rose and gray. The two men climbed into the cockpit to follow the sun into the west. Nungesser



AIRPLANE RADIO RECEIVER

This four-tube radio receiver was designed especially for use on one of the monoplanes of the Bellanca type

shouted, "Let's go!" The white plane taxied 1000 feet down the field and an escort of a dozen planes followed as far as the coast to make sure that the craft carrying the emblem of a coffin, skull and bones, got well underway with its heavy load. They watched it dash off through the early morning mist toward England and then returned to Paris to await news from America that the *White Bird* had triumphantly come to roost on Long Island. Forty hours passed; fifty, sixty, seventy! Nungesser was long overdue. Disappointment swept over France and the rest of the anxious world when reports from New York told that the plane had not been sighted and that lightning which gave it a send-off was thundering over Manhattan's skyscrapers at the hour when the plane was scheduled to arrive.

While searching parties were hunting for the *White Bird* in the North Atlantic, a youthful flier, Captain Charles Lindbergh, piloting a monoplane made a record flight across the continent, making only one stop at St. Louis enroute to Long Island, where he nestled his plane among the transoceanic aspirants gathered at Curtis Field. Twelve days later, on May 20, the 25-year old aviator climbed into the cockpit of his machine, which faced down the runway toward the east. The 200-horsepower engine roared. The blocks were pulled from beneath the wheels. The plane lumbered down the field with its 5200-pound load, the heaviest ever lifted by a 200-horsepower engine. Suddenly the wheels of the machine cleared the ground and Lindbergh was in the air with the silver nose of the monoplane *Spirit of St. Louis* pointed toward Newfoundland and the great-circle route to Europe. There was no radio on board. Perhaps the unconquerable youth left it behind because of the same psychology that prompted him to say that he was taking only five sandwiches and a bottle of water as meagre rations. "If I get to Paris I won't need any more, and if I don't get to Paris I won't need any more, either," said Lindbergh.

LUCKILY he did not need radio. Off above the trees of Long Island the silver wing-span dipped out of sight. It was 8 A.M. Throughout the day came reports from along his course that the craft was running true to schedule, and at 7:15 P.M. he headed out from St. John's, Newfoundland, over the open sea. The next morning ships sighted him off the Irish coast. Everyone who owned a radio set stayed close to the loudspeaker all afternoon and evening waiting for a flash that "Lindy" had landed. Six minutes after the wheels of the plane touched Le Bourget Flying Field outside of Paris, New York broadcasters had the report on the air, thus relieving 33 ½ hours of anxiety throughout the world.

Two weeks after Captain Lindbergh landed in France, a monoplane of Bellanca design, named *Columbia*, soared into the air at 6 o'clock on the morning of June 4, and left Long Island bound for Europe. It carried

Clarence D. Chamberlin as pilot and Charles Levine as passenger. Shortly after 8 o'clock the next afternoon the plane circled about the *S.S. Mauretania*, 340 miles from Land's End, England. Soon they were reported over Normandy and then over Germany, where the fuel ran low and forced a landing at Eisleben, about 110 miles southwest of Berlin, the plane having been in the air 42½ hours in flying 3905 miles. The tanks were quickly filled and the craft resumed its journey to Berlin. They did not travel far, however, before another forced landing was necessary and the plane came down in a marsh near Kottbus, 70 miles from the capital of Germany. In alighting, the propeller hit the ground, breaking a blade as the wheels settled in the marshy earth. Thus ended another transatlantic air voyage, the first of its kind from the United States to Germany. There was no radio on board.

COMMANDER RICHARD E. BYRD'S giant transatlantic Fokker, which made a forced landing in the English Channel after becoming lost in fog, was equipped with an automatic device to flash continuously the call letters WTW on the 690-meter wave, excepting at times when the radio was used for communication. Thus, if the call letters ceased, the receiving operators were aware that the man on the plane was going to transmit a message or that something had gone wrong. The constant stream of call letters was made possible by a little wind-driven turbine geared to a cam wheel, which caused an electric contact to make and break the transmitter's keying circuit in the sequence of code characters.

The total weight of the radio equipment was 115 pounds. Besides the automatic sending unit, it consisted of a transmitter employing two 50-watt tubes. A simple adjustment enabled the operator, Lieutenant G. O. Noville, to shift quickly from the working wave of 690 meters to the universal distress wave of 600 meters. The wavelengths were checked by a miniature wave-meter with indicator lights built into the main panel. The sending range was from 200 to 400 miles in daylight, and much further at night. The receiver was similar to a 4-tube broadcast outfit, excepting that

Herbert Photos

RADIO GENERATOR

The single-blade propeller under the fuselage drives the generator which supplies the current for the transmitter and for charging the batteries

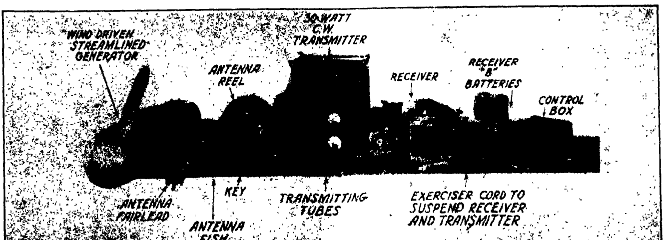
the wavelength range was from 500 to 1500 meters. Special precautions were taken to minimize interference caused by vibration and motor ignition. The antenna was a Number 18 bare copper wire with a three-pound weight on the end. It was reeled out to about 450 feet below the fuselage. The metal framework of the plane acted as the counterpoise ground.

Power for the transmitter and to charge the storage battery, was supplied by a wind-driven electric generator mounted underneath the plane about five feet behind one of the propellers. The single blade fan of the generator was regulated to a speed of 4000 revolutions a minute, regardless of the forward speed of the machine. This was effected by means of a centrifugal governor. The fan was very carefully balanced and delivered about two-thirds of a horsepower to the generator. All switching was done by a combined gang switch totally enclosed in a flameproof box, with only the handle projecting in order to eliminate any possibility of igniting gasoline fumes.

AN emergency set was carried in case the aviators were forced to abandon the plane and take to the rubber life-rafts. This transmitter weighed only 13 pounds and was so constructed that it could be operated when entirely submerged in water, a successful test having been made by dropping the set into a barrel of water. This set was designed to operate with dry batteries for from five to 15 hours. A kite was carried to hold the aerial wire aloft in case of a forced landing, giving the outfit a range of about 30 miles.

"If I had to choose between a radio transmitter or receiver as equipment for a plane in which I might plan to cross the ocean, I would most certainly select the transmitter, and a good strong one at that," said Dr. A. N. Goldsmith, Broadcast Engineer. "In my mind, being at sea in a disabled airplane would call unmistakably for apparatus that would tell some one about it and do it lustily. A good transmitter would be of much more value than a receiver in transoceanic airplane navigation, for the same reason that a man who has a good voice to rely upon in an emergency stands a better chance of attracting aid than a man who is dumb."

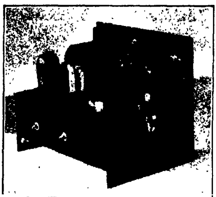
In this connection attention is called to the flight of the naval seaplane *PN-9* in its attempt to cross from California to Hawaii in September, 1925. The seaplane was equipped with a radio receiver but no transmitter. The craft was crippled en-



PARTS USED FOR TYPICAL AIRCRAFT RADIO INSTALLATION

route and was forced down on the surface of the Pacific, where it drifted for more than a week while airships and vessels searched off Hawaii. The crew listened to radio messages exchanged by those engaged in the hunt but could not answer or send a call that would give a clue to a radio direction finder. They actually received the dispatch that proclaimed the abandonment of the search. Finally, a ship sighted the plane and rescued the airmen, who were under the command of the naval flier, the late John Rodgers.

THE *NC-4* naval seaplane, the first airplane to cross the ocean in May, 1919, proved the value of radio on a transatlantic flight. It was not many hours after the *NC-4* and her sister ships *NC-1* and *NC-3* left Rockaway, that the importance of radio equipment was realized by the men on the planes and those on shore. The *NC-4* developed engine trouble soon after sailing over Boston and was forced to descend at sea off the New England coast. Operators on land noticed that the *NC-4* reported difficulties developing in the oiling system. Soon the plane was silent. Messages were sent to the sister ships asking if they could see the *NC-4*. They said that she was not in sight. The naval operators at Otter Cliffs, Bar Harbor, Maine, had been listening to the pioneers from the time they hopped off about noon. It was now 4 o'clock. They checked their radio-compass bearings and found that the last signal radiated by the *NC-4* showed that it was off Chatham, Massachusetts. This information was broadcast to destroyers. A search began along the line of the bearing. The *NC-4* was found by the destroyer *McDermott* at sunrise the next morning.



SMASHED IN A SWAMP

This is a rear view of the short-wave transmitter designed for use on the ill-fated American Legion, *in which Commander Davis and Lieutenant Wooster lost their lives in a Virginia swamp*

On June 14, 1919, Captain John Alcock and Lieutenant Arthur W. Brown, in a Vickers-Vimy bomber, flew from Newfoundland to Clifden, Ireland, a distance of 1980 miles, in 16 hours and 20 minutes. This was the first non-stop transatlantic airplane flight. The Vickers-Vimy bomber was designed with a radio direction-finder as part of its equipment. The loop antenna was built in the wings and the receiver acted as a radio compass. The world awaited anxiously for news from the airmen, but the ether was silent. The navigator was taking bearings on the waves sent out by the powerful transmitter on the Irish coast. So true was the guiding influence of radio that the plane flew directly over the Clifden towers.

Herbert Photos

THE "AMERICA'S" WIRELESS

The transmitter is shown above and the receiver below. Both sets are suspended on rubber to prevent mechanical vibration from interfering with the operation. The operator wears a helmet with the earphones built into it

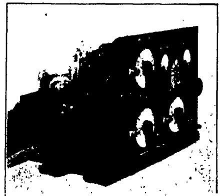
A MONTH before Alcock and Brown hopped off, Harry Hawker, an Englishman, and Lieutenant Commander Mackenzie Grieve, as navigator, left St. John's for Ireland in a Sopwith biplane. His original plans called for radio equipment, but he discarded it to lighten the craft at the last minute. Nothing was heard of Hawker and Grieve for more than a week. They were given up for lost. Memorial services were held in London. Several days later it was reported from the Orkneys that the Danish steamer *Mary* had rescued the aviators about 1050 miles out from Newfoundland, about 850 miles from Ireland. The *Mary* was not equipped with wireless.

Late in June, 1919, the British dirigible *R-34* flew from Scotland to Long Island and then returned safely to Pulham, England, piloted by Major G. H. Scott. The *R-34* was equipped with a vacuum-tube transmitter. When off Cape Race, the signals were first detected in America. When over the Bay of Fundy, the operator flashed an urgent message announcing that the fuel supply was running low and that a forced landing might be necessary. This message was intercepted at the naval station at Otter Cliffs. A "sub chaser" was loaded with tanks of fuel and sent out about 100 miles from Bar Harbor to meet and aid the dirigible. As she sailed overhead the wireless man signaled that they could reach Chatham Air Station and possibly Mineola Flying Field, which they succeeded in doing.

IN 1924, the United States Army Air Service 'round-the-world planes crossed the Atlantic by way of Greenland. They did not carry radio. It was also in 1924 that the Zeppelin *ZR-3*, later renamed the *Los Angeles*, flew across the sea from Friedrichshaven, Germany, to Lakehurst, New Jersey.

"Picture yourself," said Leo Freund, operator on board the dirigible, "in an airship for three days sailing over the ocean, and the navigator is unable to make use of his sextant to determine the position, not being able to see the sun, moon or stars. It would therefore be dangerous to make a trip of this length without radio apparatus. With radio you can determine the exact point of the ocean above which you are sailing by establishing communication with a sending station either on land or on a ship at sea."

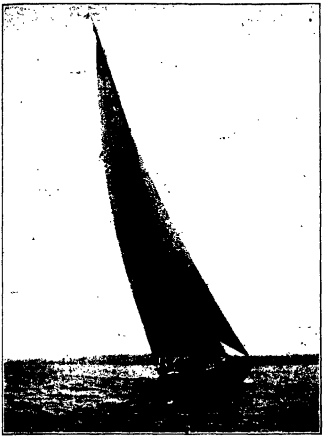
Commander Richard E. Byrd carried a short-wave transmitter operating on 40 meters to the North Pole and back to his base at Spitzbergen. The men on board the dirigible *Norge* found radio to be a "friend in need is a friend indeed," when the big ship was lost in the Arctic wastes after passing over the North Pole in the spring of 1926.

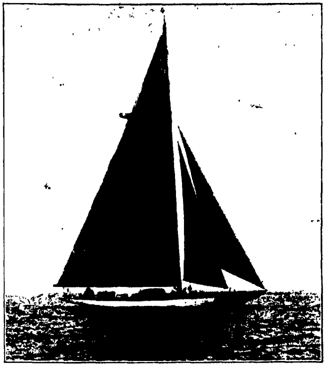


AN AIRCRAFT TRANSMITTER

A front view of the set illustrated at the left. It operated on a 45-meter wave, and its signals were clearly heard in New York when the plane was cruising over Langley Field, Virginia

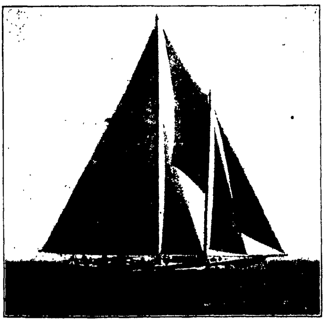
Experts call the attention of aviators to the fact that amateur operators talk around the world with simple short-wave installations, which if carried in compact form on board a plane, could reach shore with messages from any point in the Atlantic.





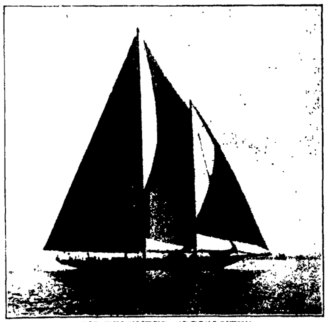
TWO VIEWS OF THE "KATOURA"

The hollow mast, 152 feet long, was the largest ever put in a yacht. Note in left-hand view, taken off starboard bow, the three sets of spreaders. The topmast section, 13 feet long, could not be held in its place; it was later removed



SCHOONER "VANITIE"

r rig she is faster than cup defender the Resolute



CUP DEFENDER "RESOLUTE"

nded America's cu

Thomas Lipton's

Sloop Versus Schooner

The cup defenders, for the past 40 years, have been "single-stickers." Last year the cup yachts *Resolute* and *Vanitie* came out under schooner rig, with which *Vanitie* proved superior. Both boats embodied the new staysail rig in place of the old gaff-headed sail between the masts. This year, that enthusiastic yachtsman, Robert E. Tod, has put in commission a new sloop of the same water-line length as the *Vanitie* and *Resolute* (75 feet), the rig being similar to that of the famous little six-meter boats. There is no bowsprit. The towering mainsail is jibheaded, and the end of the main boom is inboard, or just above the taffrail. The single mast, originally 152 feet long, has been cut down 13 feet, and now measures 126 feet from truck to deck. By the end of the season it will be possible to determine whether this sloop, with a total area of 6475 feet, can beat *Vanitie*, which carries 8018 square feet. Under schooner rig, *Vanitie* is too good for *Resolute*, especially in windward work.

Dawn-Man or Ape?

Was Our Ancestor a Dawn-Man, or Did We Descend Directly From an Anthropoid Ape of an Ancient Geologic Epoch?

PROFESSOR HENRY FAIRFIELD OSBORN, one of the most famous scientists in the world, not long ago published an article in the Sunday edition of the *New York Times* in which he maintained that the idea that man has been derived from an ape was a myth due to our ignorance of the real course of human evolution, and that humanity would be thankful to anthropologic science for having at last removed this bar sinister from man's pedigree.

In addressing the Bicentenary meeting of the American Philosophical Society at Philadelphia on April 30, 1927, Professor Osborn reviewed the recent discoveries in the field of prehistoric anthropology which had led him to these views. I, on the other hand, addressing the same meeting, said in substance that man's poor relations—the chimpanzee, the gorilla and the orang-outang—are still with us, mute witnesses of the past, that it will do us no good to deny our blood kinship with them and that the evidence of our lowly origin can hardly be waved aside on the ground of the length and aloofness of our own lineage.

Now why did Professor Osborn, the foremost champion of evolution in our time, take the stand that he has taken? And why did I, owing so much to Professor Osborn as my honored leader and friend for nearly thirty years past, feel it necessary to differ with him so publicly? And in brief, what is it all about?

Professor Osborn's side of the story may be summed up as follows: Recent discoveries prove that the human race is far older than it was formerly thought to be, even by scientists themselves.

A Friendly Controversy

When Prof. Henry Fairfield Osborn, noted paleontologist and President of the American Museum of Natural History, recently stated that "no existing form of anthropoid ape is even remotely related to the stock which gave rise to man," he spoke with sincerity, and certainly not, like many of the poorly instructed popular writers who deny man's ape ancestry, without his own scientific reasons, although much may be said against these reasons.

Dr. Osborn's espousal of the man-from-an-independent-source theory has renewed a nearly abandoned controversy in science—a friendly con-...y in this case, as the editor noted whe.. he recently saw Dr. Osborn . Dr. Gregory good naturedly debating their respective beliefs before a famous gathering of scientists. We shall ...ore of this —*The Edit*

For tens and hundreds of thousands of years in Europe great ice sheets crept downward from the north and from the highlands out on to the plains, until all northern Europe and North America were covered with vast continental glaciers, as Greenland and Antarctica are today. During these periods of bitterly cold climate, Europe was the home of such cold-defying animals as the woolly mammoth, the woolly rhinoceros and the musk-ox. During other tens and hundreds of thousands of years the climate gradually softened, the ice sheets retreated to the north or to their upland centers and tropical mammals such as hippopotami invaded Europe.

In all there were four such major advances and retreats of the ice in Europe during the Pleistocene epoch and the latest provisional estimates of geologists place the beginnings of the Pleistocene as not less than one millio years ago.

But far down in the Pleistocene age, during the First Interglacial interval, the Heidelberg man died and left his jaw, which was found under seventy-six feet of stratified glacial sands. And far below the level of the Heidelberg man, in the pre-Pleistocene deposits of the southeast coast of England, is a series of strata containing flint objects apparently fashioned into crude implements by human hands. Professor Osborn has been the great champion of their discoverer, Reid Moir, the patient investigator of Ipswich, England, who has endured the neglect and opposition of other scientists. These sceptics denied that Reid Moir's "implements" are of human origin and have attributed their resemblance to true implements to the chance knocking about of flint nodules by the action of water. But the Abbé Breuil and other famous archeologists now admit that some at least of Reid Moir's flints are of human manufacture. More than one million years is Professor Osborn's estimate of the age of even the later flint implements of the Pliocene deposits of England. And now Professor Osborn announces the discovery in western Nebraska of a whole series of implement-like bone objects which, according to provisional estimates of the age of the deposits, may be about four million years old. These bone "needles," "scrapers," et cetera, have been made out of the bones of many extinct species of horses, camels

Science Service

PROF. HENRY FAIRFIELD OSBORN

. holds that man did not descend .om an ape, but from some undiscov-.ed stem common to man and apes

Science Service

PROF. WILLIAM KING GREGORY

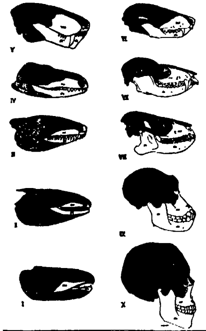
He believes that man descended from some early ape which was not unlike the modern apes in general appearance

and other mammals, whose shattered bones are heaped together in wild confusion. Moreover, close duplicates of many of these bone objects have been found in the refuse heaps of ancient Indian settlements of the southwest, and others in the ancient shell heaps of Maine.

Professor Osborn states that these are either the work of men several millions of years ago or astonishing freaks of nature. If, argues Professor Osborn, several million years ago men were already men, capable of devising and fashioning more than eighteen different types of bone implements, what becomes of the "myth" of man's origin from the ape?

Professor Osborn does not even rest his case on the validity of the Pliocene age of men in Nebraska but proceeds to show that a close study of the skeleton of the extinct Neanderthal man proves that for thousands of generations the ancestors of this now extinct race had been upright-walking men with hands and feet and all other parts of the skeleton essentially human rather than apelike in character. Moreover, he points out that the human hand has a well-developed thumb, while the thumb of all apes is reduced, the hand tending to become hook-like; that in the human foot the great toe is held nearly parallel to the other toes, while in the apes it is widely set off like a thumb; that when men climb trees they do so in an awkward human way quite different from the highly competent manner of apes.

Finally, Professor Osborn holds that the scientific name "*Pithecanthropus*" is a misnomer, that the so-called *Pithecanthropus* of Trinil, Java, was not an ape-man as the Greek word implies but a true "pro-man" or "dawn-man," walking erect and capable of human speech and human thought. This is deduced from a comparison of the "brain cast" or cast of the interior of the skull of the famous Javan fossil with those of men and apes. For Professor Frederick Tilney finds in the convoluted surfaces of this brain, areas associated with thought, imagination, reason and speech.



EVOLUTION—FISH TO MAN

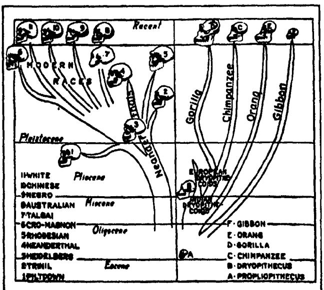
The same two tooth-bearing bones shown in white in each drawing may be traced from an ancient fish of the Devonian Period (lower left-hand drawing) through fossil amphibians (drawing II), into the line of reptilian forms (III-VI) that gave rise to the lower mammals (VII, VIII) and finally culminated in the chimpanzee stage (IX) and man (X)

And there are other lines of evidence also which Professor Osborn cites in support of his side of the argument. Again and again paleontologists have traced back the lineage of horses and elephants, pigs, cows, bears, cats, dogs and many extinct animals with Greek names, through the unbelievably long ages of the Tertiary period or Age of Mammals. But with hardly any exceptions, the earliest known representatives of these families are still recognizably different from each other, even in Eocene, or early Tertiary, times. As with the other mammals so with man, argues Professor Osborn, and most paleontologists will agree with him in expecting to find the direct ancestors of man already distinct from the anthropoid apes as far back at least as the Lower Oligocene epoch or second division of the Age of Mammals, some forty millions of years ago according to the late Professor Barrell's estimates of geologic time.

In the face of this seemingly crushing array of evidence assembled by a paleontologist of world-wide renown, can anything still be said in favor of Darwin's view that man is an offshoot from the anthropoid stock?

My reply to Professor Osborn's argument is in part as follows: Whether Reid Moir's Pliocene flints and the Nebraska bone "implements" are of human origin or not, there is other and ample evidence for inferring that man in the Pliocene epoch was already quite distinct from all other mammals.

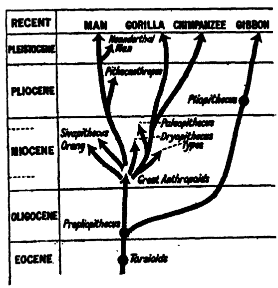
Nor do I deny that all the known fossil races of men were definitely within the limits of the human family in the main characters of brain and skeleton. Since 1916 I have written frequently that the branching off of man from a lower primate stock may not, in the present state of our evidence, be looked for later than the Middle Miocene epoch, which according to Barrell's estimates lay some ten millions of years earlier than the Middle Pliocene. Therefore the fact, *if it is a fact*, that the little-known men of the Middle Pliocene had already attained a human grade of organization, may mean only



Science Service

FAMILY TREE OF APES AND MAN—OSBORN

Oligocene times, in which Prof. Osborn believes man had his roots, ended 19,000,000 years ago, according to recent estimates based on the rate of radioactive change in the rocks



THE FAMILY TREE ACCORDING TO GREGORY

Miocene times, in which Sir Arthur Keith and Dr. Gregory believe man diverged from the ape branch, ended 7,000,000 years ago. Lower four epochs constitute "Tertiary period"

that the transitional stages between ape and man must be sought in an earlier geologic epoch.

But why assume that there were such transitional stages? Why not admit that man and ape always were different, no matter how far back we may go in geologic time? Chiefly because the sciences of comparative anatomy, of comparative physiology, et cetera, offer their silent testimony to the blood kinship, in a very real sense, of man and ape.

This evidence is scattered in a thousand technical papers; it can never be appreciated fully by the public, and has been repeatedly lost sight of even by paleontologists. No more convincing summary of this evidence has ever come to my notice than that by Sir Arthur Keith in his article on "Man, Evolution of," in the thirteenth edition of the Encyclopaedia Britannica. Let the reader who doubts the blood kinship of man to the anthropoid ape read that article with care and attempt to reconcile the facts cited there with the view that man and ape merely "parallel" each other in certain features.

If we study the patterns of the skull structure of representative vertebrates from the remote Devonian period to the Recent, and from fish to man (page 231, top) we see at once that the chimpanzee comes between the oldest fossil primates and man, and that in respect to many skull characters, man has advanced far beyond the chimpanzee but in the same direction as the latter has advanced beyond its predecessors. *In other words, even if we did not have the chimpanzee we should have to infer its existence as a sort of half-way station in the long road of ascent from the primitive Eocene primates.* Darwin's theory that man is a derivative from the anthropoid ape stock, although not from any existing type of ape, accounts for hundreds of such peculiar resemblances between man and ape. And what other scientific hypothesis can do this?

AUSTRALOPITHECUS

Restoration of the head of an extinct "man-ape" whose well preserved fossil skull was discovered at Taungs, South Africa. Sketch by A. Forestier, by direction of Prof. G. Elliot Smith

GORILLA FOETUS

A systematic study of this picture will provide some interesting comparisons between ape and man. Note the feet

Professor Osborn in his latest article seems more inclined to recognize the features of resemblance between man and ape and to account for them on the theory that man and ape have inherited them independently from a neutral primate stock, perhaps of Lower Oligocene or Eocene age. But with this admission on record, the only outstanding differences of interpretation between Professor Osborn and myself are: (I) the age of the origin of the human family from the inferred ancestral group, and (II) the leading anatomical characters of the "neutral" or common ancestral stock which included both "dawn-men" and apes.

(I) As to the age of the separation of man and ape from the common stock, the chief reason Professor Osborn has for placing this date as far back as the Lower Oligocene or Eocene is that many other modern families, such as those of the horses and the tapirs, were distinct from each other as far back even as the Lower Eocene. *But as yet no one has cited evidence tending to prove that the rate of drifting apart between the families of men and of the anthropoid apes has been the same as it is known to have been between the families of the horses and tapirs.* On the contrary, it is a fact that the variability or measure of variableness in respect to the patterns of the molar teeth is far less in the families of horses and tapirs than it is in the families of men and of anthropoids. Just as domestic animals are highly variable or unstable and subject to evolutionary changes, so too, the evidence shows that the anthropoid apes and man are highly unstable and subject to evolutionary change. The millions of years and tens of thousands of generations between the "almost human" apes of the Miocene epoch and the primitive men of later Pliocene times would therefore appear to be a sufficiently long time for Nature to transform a primitive anthropoid ape into a primitive man, especially under the severe stress of the change from forest-living to life in the open. No direct evidence has ever been brought forward to the contrary and no one has shown why chimpanzee, gorilla and man should resemble each other in so many ways, if their ancestors parted company as long ago as the ancestral horses did from the ancestral tapirs.

(II) Admitting as Professor Osborn now does, that men and the existing family of apes arose independently from a "neutral" group ancestral to both, the question arises, what were the anatomical characters of *that* ancestral group? To this question Professor Osborn answers that the primitive dawn-men were ground-living primates, more resembling men than apes in essential features; while I adhere to the older view that the dawn-man stock were erect-walking, tailless descendants of a tree-living stock, with divergent great toes, low brows and poorly developed thumbs.

For the final settling of this question the greatest need is not only more facts but more sustained and intensive consideration of the thousands of facts already on record. In conclusion, I hold that to make inferences concerning *the rate of evolution of man* from the known rates for widely different mammals is unwarranted; that the man-anthropoid group has been a remarkably plastic group, and that the evolution of man was greatly accelerated.

Courtesy the New York Zoological Society

CHIMPANZEE

Of the four living anthropoid apes—the chimpanzee, gorilla, orang and gibbon—the chimpanzee is most like man in his psychology; however, the gorilla is somewhat closer to man in his brain

CATCHING A COBRA

At the laboratory where snake venom is collected for the purpose of making a serum for the treatment of snake bites, the captive snake which has been selected for the extraction process is released from its cage, and immediately recaptured by hand. This is accomplished as shown at the left. The snake catcher at once places a heavy stick just in back of the cobra's head, and at the same time places one of his feet on the snake's tail. With the reptile thus held securely, the captor can grasp it just to the rear of the head, with one hand, and thus hold the snake without fear of being bitten. Because of the fact that the snake's tail is secured, it is impossible for the reptile to writh about and possibly cause its captor to release it, with probable disastrous results. These snake handlers, however, are experts in their work, and can carry on without fear of personal harm from the reptiles

Central Press

EXTRACTING THE POISON

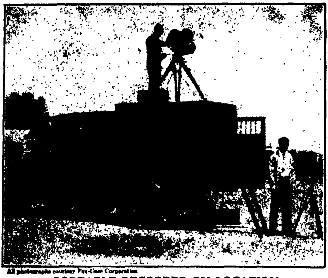
The cobra's fangs are held over a glass having a rubber cov- [illegible] and the [illegible] squeezed from the glands

FEEDING A COBRA

The reptile is held at full length, with tail held down, and milk is fed to it through a glass funnel as shown

Extracting Snake Venom For Use in Serums

At the government laboratories at Parel, Bombay, India, a section is devoted to the care of snakes, especially cobras, whose venom is to be collected and employed for making serum. This serum is to be employed for treating victims of snake-bite. The three photographs which we reproduce above were taken at these laboratories, and serve to show the care which is employed in handling and feeding the dangerous reptiles. After the venom has been extracted from the glands of the snake by manipulation performed in the manner shown, the snake is fed on milk and returned to its cage. Here it recuperates, and a further supply of the poison accumulates. The extracted venom is used for injection into horses. This is done in gradually increasing doses, and finally a serum, which is an excellent antidote for snake-bite, can be obtained from the horse's blood. This serum is obtained by drawing several pints of blood from the horse and carefully separating the serum from the blood corpuscles. The material is then passed through a process whereby all bacteria are excluded. Such serum is now in wide use for the treatment of snake-bite. The same process is employed for making serum from rattlesnake venom.



All photographs courtesy Fox-Case Corporation

PORTABLE RECORDER ON LOCATION

it for photography and sound
a "news reel" is to be made

INTERIOR OF THE TRUCK

The operator is working the gain control on the amplifier which supplies current for voice r

Sounds Recorded On "Movie" Film

New Process Opens Wide Field for the Production of Satisfactory "Talking Motion Pictures"

By A. P. PECK

IN the June issue of this magazine, the writer described what was at the time the only "talking motion-picture" process that was in actual production, and promised details of other systems. Since the writing of the article mentioned, another method, which has been in the laboratory stage for several years, has been perfected and placed on a basis where theaters can be equipped with the necessary reproducing apparatus and can be supplied with films at regular intervals.

This latest system has been assigned the name of "Movietone" and is being fostered by the Fox Film Corporation and the Case Laboratories. The later concern has been active for many years in the field of developing photo-electric cells and kindred apparatus. As in the case of Vitaphone, the method heretofore described, the sound amplifying and reproducing instruments are supplied by the Western Electric Company.

The Fox-Case Corporation, as the producing concern is known, has equipped an elaborate studio for the actual production work. There are two rooms or studio stages in which production can go on either separately or simultaneously as necessary. Both studios are large in size, to allow for elaborate settings or large orchestral accompaniment; both have the usual equipment of lights used in motion-picture production as well as the special apparatus required by the sound-recording process.

The walls of these rooms are absolutely sound proof, so that it is never possible for outside noises to penetrate either room while a picture is being taken. In order to insure this complete isolation, each of the studios is wholly enclosed with a double wall. These walls are slightly over one foot in thickness, including an interior air space of six inches. Either side of this air space are three-inch walls of gypsum blocks and to the outside of each of these layers is an additional thickness of a material of cellular texture. On the inside of the studio walls this material is covered with heavy draperies of a sound-absorbing nature. Other similar draperies are hung about the studios. By this means, perfect acoustic conditions have been obtained.

The air in these rooms is changed every three minutes, purified by a washing process, heated in the winter, refrigerated in the summer, so that a constant temperature is always maintained.

The production of a Movietone picture does not greatly differ from the ordinary motion-picture production of a similar subject. The settings are constructed and lighted in the same way. A rehearsal is held before the actual picture-taking is made, such a often done in ordinary picture-making. While the action in a "talking-movie" rehearsal is being checked up by the director sitting behind the camera, in another room the vocal director checks up the tonal quality through the simple method of having a loudspeaker connected with the microphone in the studio. By this means, defects in amplification and modulation can be detected and corrected at once. Also, the placement of the microphone can be determined accurately before actual recording is started.

Aside from the fact that the camera is motor driven and is connected by wire with the telephonic apparatus, there is little difference between the recording of picture and voice by a Movietone camera and the ordinary picture recording in a motion-picture studio.

In the new process, standard motion-

Now the "Talking News-Reel"

For years we have been entertained by the various happenings of the day as presented by motion pictures, and have used only our eyes in doing so. Now we can both watch and hear the prominent personages of the day, the results of great disasters, the taking-off of an airplane for another epoch-making flight, and the like. The "talking movie" has invaded the field of the news-reel, and this has been made possible by the system described on these pages. The equipment necessary has been made so compact that it can all be carried on a motor truck and so can be rapidly transported to the site of an important happening. —*The Editor.*

picture film is employed. On this film is recorded both the moving picture and its sound accompaniment, whether the latter be vocal, instrumental or incidental. In its basic elements the process is simplicity itself.

It consists, briefly, in photographing variations of light intensity on moving-picture film. This is accomplished by collecting the sounds to be recorded through the of a microphone, which has the property of changing sound variations into electrical variations. These electrical variations are amplified, and in turn vary the intensity of the recording light.

THIS light is illustrated in these columns. It contains a filament and plate, similar to the two-element vacuum tubes that were used to some extent, many years ago, in radio reception. The filament is coated with an alkaline earth oxide, from the initials of which the name of the light, Aeo, is obtained. The filament and plate are sealed in a small quartz tube, from which the air has been removed and helium gas has been substituted. This tube is connected in the output circuit of a transformer, the input of which is connected to a vacuum-tube amplifier. This latter unit is placed in the circuit so that it steps up the impulses from the microphone, and so supplies these variations of current to the recording tube in a strengthened form.

The filament of the tube is connected to a low-voltage battery, while a high-voltage battery is placed in the plate circuit. When the apparatus is in use, the filament is lighted by its battery, and the plate current is turned on. The filament battery is then disconnected and the flow of current within the tube causes the action to be carried on. The glow emanating from the tube is of high actinic value, and the fluctuations of its intensity, corresponding with the sound variations as they affect the microphone, are rapid and accurate. Because of this, the variations of light as they are recorded on the sensitive film are faithful in their gradations as compared with the sound fluctuations delivered to it electrically.

SOURCE OF THE RECORDING BEAM

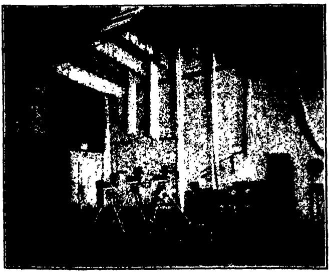
From this special vacuum tube comes the light which records on the film the variations which are later to be transformed to sound waves

The recording light is inserted in the back of the camera in such a manner that the variations in light intensity fall directly upon a narrow edge of the negative film on which the motion picture is also simultaneously being recorded.

The width and length of the tiny beam of light that falls on the negative are rigidly held to the proper limits by a novel means. Situated between the Aeo bulb and the sensitive film is a quartz plate on one surface of which has been deposited a silver film. A slit .00008 inch wide by .01 inch long is cut through this layer of silver. This slit governs the size of the fluctuating beam as it reaches the photographic film, and prevents the light from affecting any more of the film than just that part assigned to the recording of the sound. The use of this system was decided upon after repeated attempts to employ slotted metal sheets all resulted in poor recording and reproduction, due to imperfections in the cutting of the metal, dust collecting in the slot, and the like.

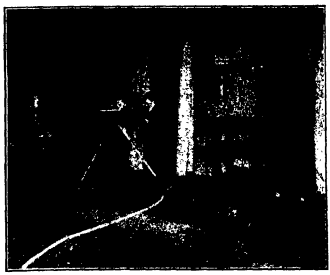
The entire action of recording graphically depicted simplified form on page 236. In this drawing we show the source of the sound at 1. The sound waves, regardless of what the source may be, are set up in the air, and are indicated by 2. These strike the microphone and vibrate the diaphragm. Thereupon, electrical fluctuations, corresponding to the sound waves, are sent along the wires 3 to the vacuum-tube amplifier. Here they are built up and sent along the wires 4 to the Aeo light 5, previously described. After passing through the slit in the silvered surface of the quartz plate, indicated by C at 6, the fluctuating rays of the light strike the sensitive film A. When the film has been developed and printed in the usual manner, the finished positive has the appearance shown at 7.

THE process of reproducing the sound and pictures in this new system is practically the reverse of the recording system. The standard film, containing both picture and sound in a photographic record, is run through a standard moving-picture projection machine, to which has been attached a sound-reproducing unit. This includes a light, which is focused by a lens system through a narrow slit onto the sound record of the film. This slit is the same as the one previously described. As the sound record on the film passes by the slit, it



IN THE "TALKING MOVIE" STUDIO

Three of the special cameras are shown. The sound-proof booth to the left is used when the conditions require quiet



PART OF THE RECORDING EQUIPMENT

To the reader's right is shown the vacuum-tube amplifier panel and the storage batteries which supply the current

interrupts the constant light shining through it, and sets up light variations corresponding directly to those photographed. These changes in light variation then fall on a photo-electric cell, which changes the light variations back to electrical variations. These electrical variations are then amplified and carried by wire from the projection booth to the screen where they are reproduced with great fidelity through loudspeakers.

THE particular photo-electric cell used here is worthy of further mention. It is essentially an extremely sensitive relay which is actuated to varying degrees by the fluctuating beam of light as the rays pass through the sound record on the film. The cell consists of an evacuated glass bulb, the inner surface of which is partially coated with a film of barium. One electrical connection is made to this film. In the center of the bulb is a filament which is burned only when the cell is in the process of being made. The other connection is made to one of the terminals of this filament which is used only as an electrode.

When the cell is finished, and connected to the in-put of a vacuum-tube amplifier, a beam of light passing through the glass wall and striking both the filament and the barium film will form a conducting path, the resistance of which will depend on the intensity of the light beam. It will thus be seen that, as the light beam, fluctuating in accord with the sound currents, enters the photo-electric cell, a current will be set up in the circuit of the cell, which current will vibrate in synchronism with the intensity of the light, and therefore in synchronism with the original sound wave. This current, when used to actuate a reproducer, will then set up other sound waves which will be exact reproductions of the originals.

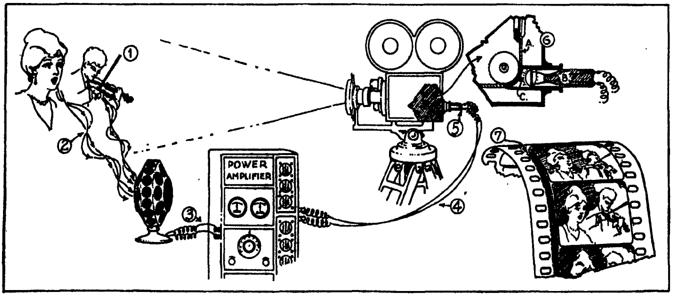
In the new process, aside from its own various particular patents, such as for example, the Aeo tube, certain telephonic apparatus is necessary. This embraces the use of such devices as amplifiers, microphones, and loudspeakers, both in recording and reproducing. Wherever telephonic apparatus is employed the devices of the Western Electric Company are used. These are the instruments which were acquired by Vitaphone under an exclusive license from Western Electric, and the use of which by Movietone is covered by an agreement between the Fox-Case Corporation and the Vitaphone Corporation. Since the telephonic equipment, which is the principal part of an installation, is common to both Vitaphone and Movietone, reproducing attachments for these two systems are now being so designed that both can be put on the one projection machine. This enables the exhibitor, after having secured installation, to reproduce both Vitaphone and Movietone pictures, using the same machines.

MANY advantages are claimed for the process just described. Of first importance, it is pointed out, is the fact that the sound and the picture are contained on the same strip of film, so that it is never possible for them to become separated. Neither is it possible for sound and picture to get out of synchronization. Thus it is not necessary for the operator to start the picture at any one spot. In case of film breaks, where it is necessary to cut out more frames in order to splice the film together, there is always a loss of the same amount of sound as there is of picture, so that this in no way disturbs synchronization.

The inclusion of the sound on the strip of standard film means that no extra cost or difficulty in handling is experienced in shipment of the pictures. In fact, these films can be handled in all respects the same as ordinary picture film.

An advantage seen in the recording process comes from the fact that the recording cameras are an adaptation of the standard motion-picture camera, motor driven, and can be handled with the same facility as the ordinary camera. There are no unusual restrictions in the handling of this recording equipment, and it can thus be placed for any desirable shots, and changed from distance to close-up range at will without any preparation other than refocusing.

IN addition to having almost all of the outstanding advantages of other methods of recording and reproducing, the Movietone has one other, and that is its portability. Because of the fact that all of the recording apparatus can be mounted in a truck and carried from place to place, this newest process lends itself to the filming of news reels and the like. Thus not only the features and gestures of prominent persons, but their voices as well, can be preserved for posterity. Many news events will be found to be vastly improved in human interest when the sounds incidental to the actions are recorded and produced in absolute synchronism with those actions. The use of the equipment in portable form does not distract from its practicability in any way, as the apparatus mounted on the truck is practically identical with that which is ordinarily employed in the studio.



THE CYCLE OF RECORDING "MOVIETONE"

From the source, 1, come the sound waves, 2. They are picked up by the microphone and the fluctuating current is led by the wires, 3, to the amplifier. The stepped-up current follows the wires, 4, to the recording light, 5. Within the camera, 6, the film, A, is exposed to the rays of the light, B, through the slit C. The voice record in finished form is shown at 7

TOWERS THAT CARRY THE WIRES

ONE OF THE WATER WHEELS

Here a shaft and one of the water-turbine wheels are b lowered into the position in which they will operate

World's Largest Artificial Lake

The New Martin Dam in Alabama Provides 530 Billion Gallons for Hydro-Electric Power Development

ALABAMA is building what is declared to be the largest artificial lake in the world. It will form part of the great hydro-electric project of the Alabama Power Company. The lake will be impounded above Cherokee Bluffs on the Tallapoosa River, and will have an area much greater than the city of Birmingham and all its suburbs. It will cover 60,000 acres of farm and forest land in three counties.

Compare the 530 billion gallons at Cherokee Bluffs with the 170 million gallons at Muscle Shoals. The Ashoken and Kensico reservoirs, from which New York City draws its supply, contain but 200 billion gallons combined. The Hetch-Hetchy reservoir, for San Francisco, has an initial capacity of 67 billion gallons, which will be increased as the city's needs expand to 116 billion gallons. The Pathfinder dam of the United States Reclamation Service contains 330 billion gallons.

THE new reservoir will assure four and one-half feet of water for navigation in the Alabama River to the Gulf of Mexico. The Tallapoosa flows into the Alabama. Furthermore, the danger of overflow in both the lower stretches of the Tallapoosa and the Alabama will be reduced to a minimum. This new body of water—christened Lake Martin—is 63 miles southeast of Birmingham. At one point it is 19 miles wide. An encircling driveway would be about 700 miles long and would be one of the most attractive scenic drives in the whole country. The dam was closed in June, 1926, when the Tallapoosa River began backing up and filling the lake.

It was necessary, in order to construct this project, to build a city of 4000 people and to extend a railroad. Under the terms of the Federal Water Power Act, trees whose tops will protrude above water must be felled and the shore line must be swept clean for a distance of 20 feet above

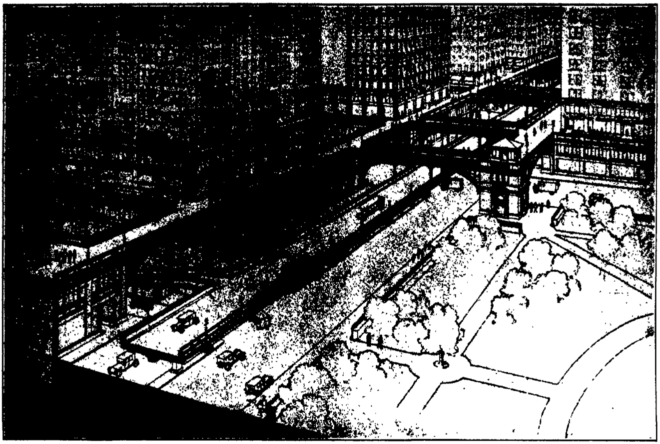
and thus eliminate mosquito-breeding places. This work alone has called for the expenditure of one million dollars and the employment of 2000 workmen. Light logging methods were followed. Modified tractors were used for piling the refuse. Piling devices were employed that consisted of a cable and drum operated by the tractors.

The development will have three 45,000 horsepower generators, making a total of 135,000 horsepower. A fourth unit is to be added later. Each unit is sufficient to operate a row of street lights spaced 125 feet apart on each side of a roadway extending from Birmingham, Alabama, to Minneapolis. If a person will visualize four straight roads extending from Birmingham to Minneapolis, each having street lights at intervals of 125 feet along each side of the highway, he will obtain a clear conception of the enormous capacity of this new development.

The water wheels operate at heads varying from 150 feet, with the reservoir filled, to 90 feet when it is at the level of greatest draw-down. The dam, which has a maximum height of 200 feet, is 2000 feet long and is of the usual gravity type with flood gates at the crest of the main section. It is shaped like an elongated letter "S" with the main portion of concrete, 250 feet long, curving upstream and portion reversed urvature and composed of an earthen concrete orewall.

PRIOR to the start of actual clearing of the land, permits to change the location of twelve cemeteries were secured and 900 graves were moved to location outside the flooded area where land was purchased by the company and donated to local community churches. It was also necessary to relocate several miles of railroad and 100 miles of highway. A plate girder railroad bridge and a reinforced concrete bridge 2500 feet long were constructed.

The total cost of the project will be 20,000,000 dollars in round figures, a considerable portion of which was required to secure and clear the immense area covered by the reservoir. So far as changing the map is concerned, this is one of the most elaborate projects ever undertaken in the southern states.



HOW PEDESTRIAN AND VEHICULAR TRAFFIC CAN BE DISPOSED

This view is supposed to be taken from a public square, looking towards the intersection of two streets in a part of the city where the proposed plan has been carried out. In the lower left-hand corner, the automobile runway and part of a building are shown in section. Here is depicted the benefit which would accrue to the third story by reason of the elevated walks. Shops facing on promenades of the kind shown would certainly be of great value. Thus the offsets would prove a source of revenue to owners, instead of a loss

The City of the Future

Proper Design of Highways, Buildings and Sidewalks Will Reduce City Congestion to a Comfortable Level

By ERNEST FLAGG

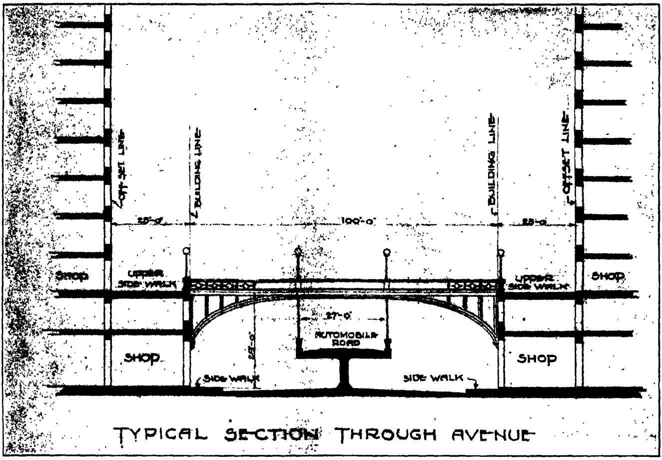
AMERICAN cities are now drifting into what will soon become an impossible situation, a fact which it is folly to ignore. Every day's delay adds to the difficulty and cost of doing what in the end must be done to correct it. It is fast being forced on public attention that streets intended for horse drawn vehicles and walk-up houses are inadequate for cities of three times the former height.

As the present width of streets is based on ages of experience, it is reasonable to suppose that they were properly proportioned for what *was* required of them. That they were so designed is proved by the fact that almost as soon as more pressure comes, trouble begins. It is clear, therefore, that if cities three times the former height are to be built successfully, street capacity must be proportionately increased. It would seem that this fact should be as clear as that one and two make three, yet most men here, otherwise intelligent, fail to grasp it. In Europe, perhaps from longer experience, the matter is better understood. No European city has been beguiled into our way of building. The European has object lessons before him which show what can and what cannot be done with impunity in this respect.

At the time of the first Zoning Commission in New York, inquiry was made of the principal European municipalities as to the greatest practicable height for buildings. The response was almost unanimous that it should be once the width of the streets. The justness of this conclusion appears from what we now see about us.

The reason that what appears so obvious to the European is not generally recognized here, is, as stated, probably due to lack of experience. We have no completed cities such as they have. Paris within the walls may be called a completed city and is probably the highest in the world, for the average height of the buildings is considerably greater than in any American city, notwithstanding all our building.

Anyone of intelligence who will examine conditions in Paris must admit that the streets have all they can properly care for, both as to traffic and light. Therefore, to suppose that two such cities could be successfully built, one on top of the other, on the same street plan, would be foolish. Yet we, on a much worse street plan, are merrily proceeding to build at least three such cities one on top of the other. The proof that these attempts are bound to end in failure unless some



USING ALL AVAILABLE SPACE FOR TRAFFIC

The centrally supported runway for fast automobiles here indicated would not interfere with the usefulness of the roadway below, because of its central supports. Space for the upper sidewalks is obtained by offsets from the building line above the second story. Offsets for light must be made in any event and as here arranged they would, by increasing street widths, be of maximum service in supplying light both for buildings and streets. Besides supplying width for sidewalks, they would greatly increase the value of the story at which they are placed, by making it available for shops. Bridges similar to the one indicated would cross streets in line with the sidewalks so that pedestrians could proceed without interruption by any kind of traffic

way is found for increasing street effectiveness, is now becoming so apparent that "he who runs may read."

The necessity for increased light is quite as great as the necessity for increased traffic facilities. As these gigantic buildings multiply, they darken each other and convert streets into deep, narrow, gloomy canyons. It is hard, therefore, to see how high building can continue without increased width of streets, for without that, neither sufficient light nor sufficient room for circulation can be had. As soon as this truth is admitted, the way becomes easier, for then it is no longer a question of what to do, but simply how to do a definite thing.

Congestion of streets is caused by interference. If progress through them could be continuous and fast for all classes of traffic, their capacity would certainly be considerably more than doubled. Therefore, the obvious way to obtain a great increase in effectiveness is to take advantage of this fact. At present three classes of traffic are moving, or trying to move, at the same level, all getting in each others' way. They are fast vehicles, slow vehicles, and pedestrians. The slow-moving vehicles set the pace and cross currents stop it altogether. It is clear that if these hindrances could be avoided, a great gain might be had independently of that supplied by any increased width required to carry out the plan.

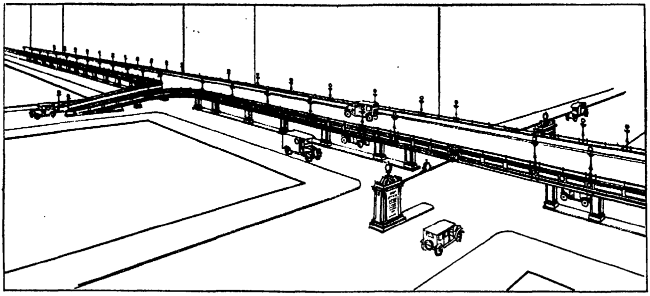
ONLY the day before I write I had an interesting and instructive illustration of this truth. Coming by motor to New York from White Plains through the beautiful Bronx Parkway, progress was fast, although the volume of traffic was enormous. For more than 20 miles there was no interference, for cross roads were carried overhead on bridges. All went well until within about two miles of the first grade crossing at 233rd Street, from which point back for these two miles there was a solid mass, so to speak, of automobiles. This was occasioned by the fact that in order to accommodate the cross traffic at 233rd Street, it was necessary to make periodic stoppages of traffic on the parkway. The consequence was that it took about as long to make the one crossing as to go the preceding ten miles.

A practical way, therefore, to obtain an enormous increase in capacity is to so separate the various classes of traffic that each can move independently at its proper speed and without interruption.

When this is once admitted, another obstacle to a proper plan is removed, for it is then no longer a question of what to do but simply how to make the necessary separation. As to that there is little choice. Space below ground is pre-empted for subways. The separation then must be made above ground if made at all, and it can only be done by the use of different levels.

It appears that the easiest and most practicable way to deal with fast moving automobiles is to provide runways centrally supported on the axis of the avenues so that the supports shall not interfere with traffic at the street level. Such an arrangement is here proposed. These runways are intended to do for automobile traffic what express tracks do for fast railway traffic. The construction of the runways can be understood by reference to the drawings.

Next, as to pedestrians: To increase light for buildings and streets, offsets from the street line are proposed



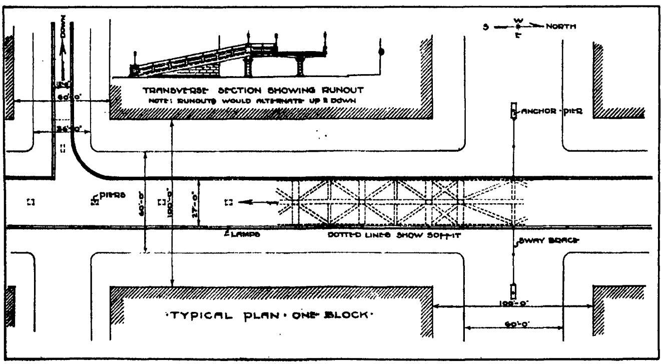
EXPRESS HIGHWAYS CAN CROSS OTHER STREETS IN THIS WAY

chorage for guying the runway to prevent side motion. *and the means for bracing it are shown in plan below*

above the second story, as stated, so that the main front of the building beyond this height would be set back 25 feet from the building line, thus affording room for elevated sidewalks, carried across streets by bridges and through old buildings at the story height. Thus in business districts two tiers of shops might be had, one at the street level and one at the sidewalk level, (see all drawings). The sidewalks would naturally add greatly to the value of the second story above the ground and afford delightful promenades where pedestrians could move in comfort, safety and without interruption. They would be reached by elevators in private buildings and by public elevators and escalators.

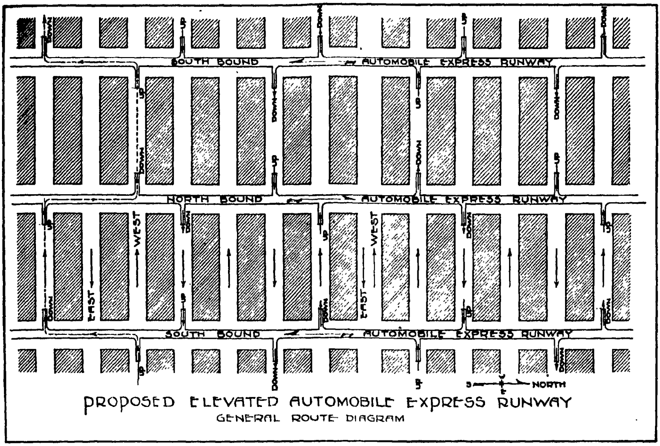
For greater convenience in explanation, the perspective drawing has been taken as if from a public square, the view being such as would be had from Bryant Park, Manhattan, looking towards Sixth Avenue and 42nd Street, supposing the city to have been treated in this way at that place. The small tower-like building in the corner of the square is supposed to contain elevators or escalators connecting with the sidewalks, street level and subway below. The gain in effective width at sidewalk level would be 50 feet and at runway level 30 feet, but the greatest gain would be in the avoidance of stops and more speed, the total increase in efficiency being about 200 percent.

A still further great gain might be had by removing present street obstructions. The elevated structures and street-car tracks are doomed in any



CONSTRUCTIONAL DETAILS OF THE PROPOSED EXPRESS HIGHWAYS

This drawing indicates the proposed method of constructing the express automobile runways. Being centrally supported, it is necessary to provide against lateral movement. No bending could occur because of the truss-like construction of the frame of the roadway, and side movement is guarded against by the anchorages on the axis of some abutting inclines on others. The construction w... nature of a great truss horizontally disposed side, supported by a single line of uprights and against lateral movement by inclines and guys to able anchorages placed on the axis of abutting



All Illustrations by the Author

HOW EXPRESS HIGHWAYS COULD BE PLACED TO BE MOST EFFECTIVE

This drawing represents a section of the city plan, showing avenues and cross streets with automobile runways on the axis of the avenues arranged alternately for one way traffic in opposite directions. Separate inclines for ascending and descending are supposed to be provided but few are shown on the drawing. To cross an avenue, a car would go up, join the traffic, work to the other side and descend by the next incline down. In this way one could cross all the avenues, without interruption, by simply going a little further. This plan should be studied in connection with the other drawings given on the three preceding pages

event and the sooner they go the better. In order to understand how great an obstruction these are, one has but to imagine an elevated railroad on Fifth Avenue, New York City, such as exists on Sixth Avenue, or car tracks like those on Broadway. In either case it is safe to say that the efficiency of the street for surface travel would be reduced from 30 to 50 percent.

Another cause of street congestion is due to the unloading of merchandise on sidewalks. All new buildings of the warehouse type should have loading platforms on the premises. Street openings and the dumping of building material on the roadways also cause congestion which might be remedied by more stringent rules.

All that has been said so far concerns conditions above ground. We have now to consider congestion of subways. Of the fourteen longitudinal avenues suitable for such roads in Manhattan, eight are now occupied either by elevated structures or subways. All these lines are carrying more than twice as many people as can be accommodated on them in decency and comfort. It may therefore be said that if every avenue had a subway under it, their total capacity would not be more than needed right now. Yet the building program has hardly begun, for at present, while the common practice is to build from 15 to 30 stories, yet it is doubtful if ½ of 1 percent of the area of the island is so occupied. The exhaustion of this means of transit is therefore plainly in sight. It has been suggested that there could be deep tunnels right and left under the rivers to Long Island and New Jersey, but their cost would be great and their construction slow. They will undoubtedly be needed in the future but cannot be relied on for immediate relief. It seems as if that might be had to a great extent by means of the viaducts, or runways for automobiles already described. They would cost less than subways and if used to full capacity might each carry in busses as many passengers as a subway.

IT seems probable that in the future busses are to play a most important part in bringing passengers into and out of the city. They have the advantage that by different routes they can reach all parts of the suburban regions, bringing them into direct communication with and through the city. This kind of transportation also has the advantage that it can be put in operation with the least delay.

The population of Manhattan is decreasing while its industries are increasing by leaps and bounds. If the movement continues it will soon be necessary to transport several million persons who all want to reach work at about the same time and go home at about the same time. If the home is far away this will not only involve great hardship on the worker, but an immense economic loss both in time and cost of transportation. It is therefore evident that the denser the population in the immediate vicinity of industries, the better, provided the homes are healthful.

There will always be many who, to obtain open surroundings for their families, will be willing to undergo great personal inconvenience, but the large majority will prefer to live near their work and they ought to be allowed to do so. But if restrictions are made on density of population within the city and near it, all available land will soon be sparsely occupied, and persons seeking homes will be driven further and further off. Therefore, instead of such restrictions, a sound policy requires the establishment of an adequate standard of light for rooms, as this plan provides.

¶ *The second installment of this article will appear next month.*

Successful Inventors—IX

The Ultimate Use of an Invented Article is What Counts, Say Two Partner-Inventors

By MILTON WRIGHT

WITH marketing an invention, there are two methods which you may use. You may start at the outside and work in, or start inside and work out. Perhaps a better way of stating the principle is to say that you may take all the factors of a particular industrial problem and analyze them until you find the invention which provides the solution. Or you may take a specific invention and analyze its possibilities until you hit upon the best merchandising system for using it to its fullest extent.

P. E. LOCKHART

The former method is the one used by P. Everett Lockhart and Charles J. Hauk, Jr., chairman of the Board of Directors and President, respectively, of the Industrial Engineering Research Company, an organization founded six years ago to solve industrial problems. Their best-known work has to do with a roll of package advertising tape used in lieu of cord by grocers and other retailers in fastening packages. In establishing this system of advertising, they have had to be not only inventors but business analysists and salesmen as well. Their reasoning in finding an ideal invention and the way to make the most of it is something which many inventors might do well to study.

To dig out the story of just how their idea was put over, Lockhart and Hauk sat down with the writer and answered frankly the questions we put to them. In the quotations which follow it is sometimes Lockhart speaking and sometimes Hauk.

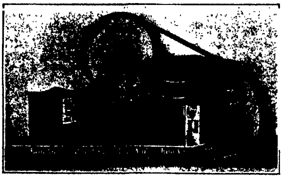
"Just how did you arrive at the little machine and the roll of gummed paper which you now use, carrying the advertisements of nationally known advertisers?" we asked.

"We started to attack this problem in its broadest aspect, was the reply. "We figured that the problem of business for the next ten years would be one of distribution. Engineers and mechanics have become so efficient that anything can be made. The best minds of the country have been focused on producing, with the result that there is a lack of efficiency in our present systems of distribution.

"Now there was our problem. Studying it a little more closely, we came to the conclusion that the solution lay in increasing the efficiency of the clerk in the store. We considered various methods for accomplishing this and came to the conclusion that what we were seeking was some automatic or psychological method by which we could sway the clerk in favor of particular goods and thus increase their distribution. The manufacturer's big job, we found, is to put his article on sale in the store. What mechanical means could we get to accomplish this?

"FINALLY we hit upon the idea of using a package sealing tape. We were not the *original* inventors. Such paper tape had been used for years but not for advertising purposes. It was used principally in factories for sealing large paper cartons. We thought such paper tape would be an excellent means of calling attention to articles sold in the stores.

"We looked around for devices we could use and located what we thought we wanted in the hands of a company in the throes of bankruptcy. As time went on, we learned that neither the tape nor the machine to feed it out was ideally suited for our purpose, but it looked good and so we acquired it. We have since had to do considerable inventing to perfect it.



DIFFERENT USES OF THE TAPE

Gummed paper with advertisements printed on the untreated side, are used as labels and for sealing packages in place of cord or other fastening

"We now had the invention which we thought would solve our problem. True, we were not the original inventors, but we *owned* the invention, and it was up to us to see what we could do with it. We called on the retail trade and placed our machines in stores."

"Did you sell these machines or did you give them away?" we interrupted.

"We sold licenses to use them. We had figured out that if the dealer owned the little machine outright we would have no control over it. On the other hand, if we retained title to the machine the dealer would be obliged to use only the tape we supplied to him. We placed about 100 machines, mostly in drug stores.

"Then we called on prospective advertisers. That is where we wore out a lot of shoe leather. It was six months after we had placed our hundred machines that we made our first advertising contract. This was with George P. Ide—1800 dollars for advertising to be placed on 2000 rolls.

C. J. HAUK, JR.

"Other advertisers followed. We took all sorts of them—drug manufacturers, meat packers, soap makers and so on. We even took advertisements for Famous Players motion-picture features. The dealers protested about the 'movie' advertising, however, and we discontinued it.

"As we went along, we were experimenting with one type of tape feeding machine and another; with advertising one kind of product and another.

"Our tape-feeding machine had to be improved constantly. The first machine we used had more than 150 parts. The machine we are using now has only three parts. The trouble with the machines we used at first was that they were too perfect. They would work splendidly in a laboratory but with the abuse they would get in the average store they soon got out of order. To be inventors had been farthest from our thoughts in the beginning, but we were obliged constantly to keep working on mechanical simplification and improvement.

"In other ways, too, we were laboring in an untilled field. For example: no printing had ever been done on gummed-paper rolls before. We started with one color, increasing the number of colors used until today we can use practically any color combination."

"But a business such as you have undoubtedly called for a considerable outlay of money, especially when you were such a long period with practically no income," we interposed. "How did you raise capital?"

"AS the possibilities of the business developed, a small group of men who had confidence in us advanced us a considerable sum—80,000 dollars."

"But were the men who put up the money really justified from a business standpoint? Was it anything more than a mere gamble with them?"

"Yes, we think they were justified. A firm of bankers looked into our proposition, analyzed its possibilities and offered us 100,000 dollars for a half interest. We feared that in time we might lose control, so we turned down the offer. The bankers certainly provided some justification for the friends who later advanced the funds."

"How many stores are using this advertising paper tape of yours?"

"About 60,000 stores, most of them groceries. This includes about 80 percent of the chain stores of the country.

"And how many advertisers are using your method?"

"About 40 national advertisers, manufacturing such well-known products as: Borden's Condensed Milk, Kraft Cheese, Muller's Macaroni, Colgate's Soap, Bon Ami, Phoenix Cheese, Beech-Nut Products, Sapolio and Duz."

"And what is the basis upon which they pay you?"

"That depends on the quantity. For smaller quantities the price is 35 cents per thousand advertisements and for larger quantities 25 cents. This price includes everything—designing, manufacturing, printing and the like."

"What would you do in the event that you did not have enough advertising?"

"That is a question which fortunately is not confronting us. At the present time we have more advertising contracted for than we can distribute on the tape. Placing the machines in stores is a bigger problem with us than getting advertising. It has become easier, however, as the dealers come to appreciate its advantages over the use of cord. Formerly, we had to use rather high-powered sales methods. The method of one of our salesmen was particularly interesting. He would walk into a grocery store where a woman was buying an order of groceries and wait until the grocer was wrapping them up. Just as the grocer took up a piece of string to wind about the bundle this salesman would raise his hand and in a loud commanding voice say, 'Stop!' Before the surprised grocer knew what it was all about the salesman had whipped a machine out of his pocket, torn a strip of the sealing tape, sealed the package with it and handed it to the customer with a bow. As she left the store he would begin demonstrating to the grocer what a wonderful little machine it was and how desirable it was to seal up packages with paper tape instead of tying them with string."

"What had become of the *original* inventor of package sealing tape?"

"HE faded from the picture long before we appeared on the scene. Probably neither he nor any of our predecessors made much money out of the idea."

"To just what would you attribute their lack of success?"

"In the first place, their application of the invention was not the one best suited for profits. They had a roll of gummed paper tape and a machine for feeding it out and cutting it off. That was all right as far as it went, but it did not go far enough. Our idea of a mechanical invention was one that would serve some purpose beyond its mere mechanical function.

"To get to the point which we are trying to make, consider an automobile. It travels; that is its mechanical function. To make its operation profitable, however, it has to do something more than merely function mechanically; it must transport people or merchandise. With gummed-paper tape and the machine for using it, the function was to seal bundles, but it was not until an additional function was added—not until it became a sales help—that profits could be made."

"But using this gummed-paper tape is more efficient than cord, isn't it?"

"Yes, it is quicker, neater and less bothersome."

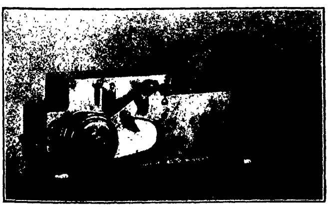
"THEN why is that superiority not enough to insure a substantial profit to the manufacturer?"

"Because the unit of sale is too small. Inventors often fail to consider the problem of the man who is going to sell the invented article. In the case of the gummed-paper tape, probably the biggest obstacle facing the original manufacturers was the fact that the sale was made to the retail dealer. Tape being so efficient and economical, the retail dealer could use only a few dollars' worth a year. It was impossible for a manufacturer's representative to call on enough storekeepers to make a decent living.

"By having advertising on the tape, however, the advertiser, not the storekeeper, becomes the individual sales prospect. The unit sale becomes thousands of times as great as the unit sale of plain gummed tape. This is so because advertisers are buying tape in large quantities for distribution to thousands of stores. The manufacturer's representative can now call on a relatively small number of prospects, but have a large volume of sales and make a good living."

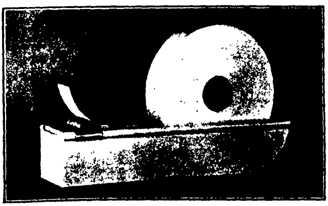
"But your theory would apply only to yourselves, wouldn't it?"

"Not at all. The money from inventions in any field is made from sales. Whatever line an inventor works in, he should make some market analysis or somebody should make it for him. Too often an inventor is inclined to think he can take it easy after he gets his patent. He cannot. The patent is only his starting point. He needs a patent, yes, but, after all, the important thing is the use he makes of it."



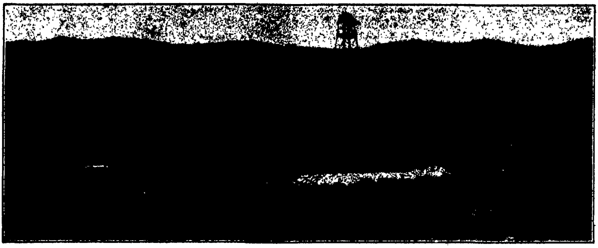
THE ORIGINAL TAPE DISPENSER

It was complicated in construction, containing many parts



THE IMPROVED TAPE DISPENSER

Far simplified, it is more practical than the original one



INTERIOR OF METEOR CRATER, AND ONE OF THE EARLY DRILL HOLES

The first exploration holes were drilled in the center of the Crater, on the reasonable theory that the round Crater could have been made only by a vertically falling projectile. But reasonable theories are often exploded by mere facts, and so it was later discovered that a slanting impact would also produce a round Crater. Most scientists accept the meteoric origin of the Crater. "I have examined the Crater on the ground, as well as the other evidence," says Prof. Henry Norris Russell of Princeton University," and I am thoroughly convinced of its meteoric origin."

The Most Fascinating Spot on Earth—III

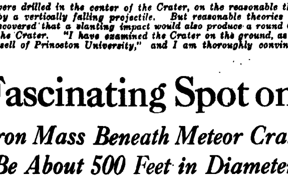
The Composite Iron Mass Beneath Meteor Crater Is Believed to Be About 500 Feet in Diameter

By D. MOREAU BARRINGER, Jr.

IN addition to the evidence of abrasion on the shale-balls, there is another and more cogent reason for believing that the mass which made Meteor Crater was a cluster of small pieces rather than a single huge iron body. One solid piece of iron big enough to make the Crater would have a pronounced effect on a magnetic needle immediately above it—and yet several accurate magnetic surveys, both with compass and dip-needle, have shown no such effect. If, however, the mass were a cluster of small pieces, the magnetic poles of those pieces would tend to neutralize one another, and therefore produce no noticeable effect at the surface of the ground. This has been demonstrated by experiment.

Now if the usual shape of the individuals of the swarm is one of rounded outline, why are not the Canyon Diablo meteorites also rounded, and why do they show, instead, the greatest irregularity of shape? Almost always their surfaces are pitted and dented with the so-called "thumb-marks," and frequently they have deep pits and cavities that in some cases extend entirely through the mass. I believe the answer is to be found in the theory I have just mentioned, that the irons found at the Crater, and many other irons which have been picked up as complete individuals, are simply the remnants of once rounded meteorites which have failed to oxidize owing to their lack of chlorine.

The usual explanation of the holes and dents in meteorites is that they were caused by the rush of highly heated oxygen through which the meteorite fell to earth—that is, that they were literally burned into the iron. But this does not seem to agree with the fact that the Widmanstätten figures disappear when the iron is heated to a far less degree than that necessary for fusion, and that all those irons which exhibit the burned-out holes and dents also exhibit the Widmanstätten figures to the very edges of the specimens. And—what is to my mind a still more convincing proof—I have frequently found the holes in the surface of iron meteorites partly or wholly filled with iron oxide, or iron shale. If the hole was caused by fusion during the meteorite's flight through the air, surely the liquid iron would not have remained in the hole, to oxidize subsequent to its fall to earth.



TYPICAL METEORITE

Astronomers have observed that when a comet's head transits the sun, it becomes invisible, showing that it is not a single solid body of matter

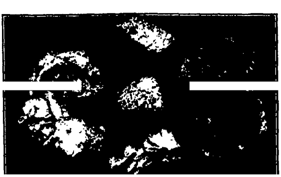
Here another question presents itself, and one on which I have sufficient data only to speculate, not to form any theories. If the thumb-markings typical of iron meteorites are caused by terrestrial oxidation after the fall, then those meteorites which have been seen to fall and which are picked up shortly afterward should lack them. I have examined the record of quite a number of meteorites which have been described in technical papers by Dr. Merrill, of the Smithsonian Institution, and others, and so far the hypothesis has been borne out by the facts. When a meteorite has been seen to fall and subsequently has been picked up, it has no thumb-marks. When it has thumb-marks, it was not seen to fall, and therefore may have been on earth a sufficiently long time before its discovery for the ordinary rusting agents of air and water to produce those marks on it. As I have said before, I cannot state this as a theory with any degree of confidence, but I believe that a further study of the available data will bear it out.

About 75 percent, or more, of the meteorite material found around the Crater has been oxidized. When sufficient allowance is made for the

oxidized material which has been carried off by wind and rain, the figure may be even higher than this. We are safe in assuming, therefore, that over 75 percent of the original bulk of the meteorites in the cluster was of the oxidizable variety of iron. Now we know that where the last churn-drill hole encountered the upper part of the buried cluster, oxidizing conditions obtain. There is no permanent water-level in the ground at this depth, and the surface waters can penetrate to and through the cluster, carrying oxygen with them. It is a fair assumption, therefore, that at least a large part of the buried mass, once solid iron, is in the form of iron shale.

MY idea of the present condition of the mass, then, is about as follows: At and near its center there will be nothing but rounded pieces of iron, more or less in an oxidized condition. The average size of the individuals, to judge from the average size of those found outside, will be in the neighborhood of five or ten pounds. Without doubt, however, there will be some of much greater size, possibly of many tons in weight. These naturally would be less oxidized than the smaller pieces. But I think the average will not be far from ten pounds, and the degree of oxidization of the average will be 50 percent or more. Near the edges of the cluster, sand and crushed silica will begin to appear, mixed in between the individuals. This will be more abundant as the outside of the cluster is approached, until there remain only a few meteorites scattered here and there through a jumbled mass of rock-fragments and silica dust.

Near the bottom of the mass I should expect to find quite a concentration of Variety B of the metamorphosed sandstone—the variety that has been fused, and has cooled and hardened to the form of quartz glass. And for a short distance around the mass itself I should expect to find fairly abundant staining by iron and nickel vapors, such as was found in very much smaller quantities in the track of the projectile, near the center of the Crater. To the north, and to a lesser degree to the east and west of the mass, the rocks are completely crushed and dislodged. To the south, however, the rocks within a very short distance of the projectile should be solid; for when the penetrat-



NICKEL-IRON SHALE

Irregular masses found on the plain near the Crater. They represent decomposition of shale-ball meteorites. One is cut in section and polished

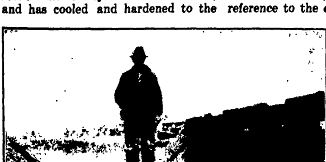
ing force of the projectile ceased, so also did its shattering force on the rocks ahead. I do not believe that it shattered much rock ahead of it which it did not immediately throw either out of the hole or backward into the lower portion of the Crater.

So far as the last drill-hole can testify it bears out this description of the condition of the mass. All the meteoric material encountered by it was oxidized, and seemed to be scattered in the shape of rounded balls through the crushed sandstone. The deeper the hole got the more abundant became these balls, until, as I have said, they were forming about 75 percent of the ground when the drill finally stuck and broke.

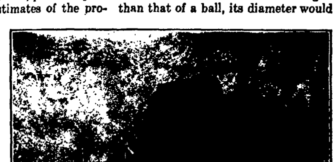
I have omitted, so far, practically all reference to the estimates of the projectile's weight, and the methods by which those estimates were arrived at. This is because this question is perhaps the least well-known of any of the main points about the phenomenon. There are several unknown factors, and hardly enough known ones with which to effect an accurate solution.

The first method used was suggested by a reference in an old handbook on artillery, to a formula for computing the probable effect of bombarding masonry with round shot. Roughly, this formula stated that where the diameter of the shot was 1, the depth of the hole would be about 2, and the diameter of the hole about 7. Applying this to the observed features of the Crater, and sidering the average depth of the original hole before it partly refilled by returning fragments to have been 1100 feet, w find that a diameter for the projectile of 550 feet closely satisfies the formula.

ROUGH though this computation seems, it is checked fairly closely by others which go into more refinements. Dr. Elihu Thomson and Dean Magie of Princeton, both of whom have taken a very great interest in the problem for a long time, have made a number of calculations on this point. They assumed speeds for the projectile of from two to ten miles a second (faster than which it is unlikely to have been moving) and made rough estimates of the amount of work involved in crushing and largely throwing out of the hole some 350,000,000 tons of rock. Their results have usually given somewhat smaller sizes for the projectile than 550 feet in diameter, so that the weight we now accept is that of a sphere of about a 400-foot diameter, which would weigh about ten million tons. As the mass was probably more in the nature of a load of shot in a shot-gun than that of a ball, its diameter would



MORE EVIDENCE



THE SHAFT IN 1903

In 1903 a 200-foot shaft was sunk inside the sand was encountered and therefore the w

be somewhat greater than this, but the weight would be about the same.

Another subject on which I have not touched is the question of the age of the hole. We know definitely that it cannot be less than 700 years old, for a cedar tree with that number of annual rings was found growing on the rim. And we feel sure, from the lack of erosion, particularly of chemical erosion on the limestone, that it can not be more than 5000 years old. Between these two limits, then, will probably be found the true age of the Crater.

In this connection there may be a good deal of interest in the fact that the Navajo Indians, who inhabit that region, are said to have a legend about the Crater that coincides very closely with what actually occurred there. By itself, a hole in the ground would not be likely to stir the imagination of the Indians, for they are perfectly familiar with the many volcanic craters of the San Francisco Mountains 50 miles or so away and attach no importance to them whatever. But about the Meteor Crater they have very marked superstitious beliefs, and it is said that they have a legend which describes the descent of one of their gods from the sky, in clouds of fire, to bury himself in that particular spot. Whether any weight should be attached to this story I do not know. It is true that the Indians will not carry away or use any of the iron meteorites. Needless to say, the newspaper writers have always placed great emphasis on this legend.

A ROUGH outline of the principal facts, then, is as follows. We know that an iron meteorite made the hole. No terrestrial explosion could cause it without disturbing the underlying rocks, no means other than a slanting impact could cause the symmetry of the rim, nothing but a smashing blow could pulverize the grains of the white sandstone. (I can take a handful of sand and reduce it to powder with a hammer, but I will not undertake to do it with steam). The fused silica, the absence of igneous rocks, and the coincidence of the meteorites and the hole are further proofs.

If a meteorite made the hole, it must have either remained in it, or bounced out, or flashed into vapor and disappeared. It could not have vaporized for the vapor would have left abundant and indestructible stains. It could not have bounced out, or the hole would be a trough instead of a circular basin. Therefore it must still be in the hole.

SHALE-BALL METEORITES

Dug out of the silica. They have nickel-iron centers surrounded by oxides

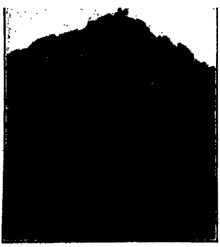
Its chemical composition can be inferred from the specimens outside the hole, for there is no reason why they should differ in composition from the whole mass. Its location is determined from the symmetry of the crater. And from the shape of the shale-balls, and the lack of magnetic effect on the surface, the theory that the mass is a cluster instead of a single body is deduced.

This is about as far as observation, deduction, and speculation has carried us toward an accurate visualization of what happened when this gigantic missile from space struck the Arizona desert, and what has since happened to it. But the fascinating fields for investigation that open out from here are innumerable. To an astronomer it gives promise of shedding a flood of light on theories of the origin and building up of our solar system and others like it (if there are others like it.)

A GEOLOGIST is attracted by the evidences to be found of the behaviour of rocks under sudden stress, and the later effects of chemical action, underground, on this comet which has suddenly turned into an ore-deposit. A chemist or a physicist will want to investigate the very peculiar properties of the nickel-iron alloy of which the iron remnants are composed, and to understand further the formation of the unusual compounds of metals found in it. An archeologist will be interested in finding what effect, if any, the fall of the meteorite may have had on a primitive race that may have inhabited the region at the time. And many other branches of science will be affected, directly or indirectly, by further disclosures at the Crater. The greater part of these investigations must wait, probably, until further exploration has shown up the main mass of the meteorite itself—a consummation which we are now trying hard to bring about.

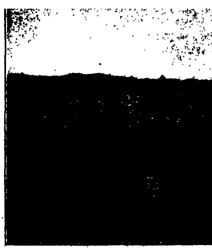
One very interesting by-product of the investigation is the resurrection of the theory that the moon's craters are not volcanic, but are the results of impacts similar to that which made the Arizona Crater (Daniel Moreau Barringer, Sr., "Volcanoes—or Cosmic Shell-Holes," SCIENTIFIC AMERICAN, July, 1924). The two chief objections to this have been: first, that practically all the lunar craters are round, and therefore the projectiles, to have made them, must all have fallen vertically, which is not likely; and second, that the moon has 30,000 craters, while the earth has only one little one. The first objection will be disposed of by the rifle-and-mud experiment I have mentioned, and the second by a consideration of the fact that there is no erosion on the moon and never has been, and therefore that the records of impacts may remain visible there for millions of years, while those on the earth have been obliterated in a few score thousand years. With these two objections removed, I think the theory, if not proved, is at least worthy of most serious consideration.

THROUGHOUT this discussion, I have not stopped to give the proper acknowledgments of the sources of my information. Whatever I have learned about the problems at the Crater, I owe to my having had the privilege of being closely associated with the men who have done the work and spent the study on it that the phenomenon deserves, chief among them being my father, Dr. Elihu Thomson, Dean Magie of Princeton and a few others.



BARRINGER POINT

Stupendous masses of rock were heaved out on the rim by the heavy impact



EAGLE CLIFF

A derrick of one of the early drill holes shows faintly down below in the Crater

Wide World

HARVARD COLLEGE CREWS AT PRACTICE

The shells shown in this illustration are of the eight-oar type discussed in the accompanying article. The amount of work done by the oarsman under racing conditions has been carefully studied and the results are given

What Determines Rowing Speed?

Tests in Specially Constructed Tanks Have Revealed Some Interesting Data Relative to Work Performed by Oarsmen

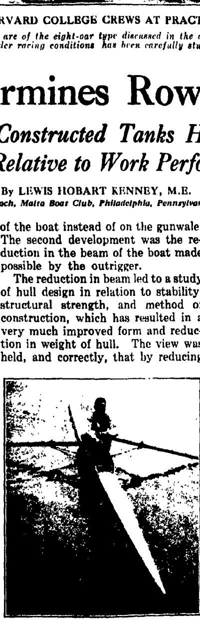
By LEWIS HOBART KENNEY, M.E.
Coach, Malta Boat Club, Philadelphia, Pennsylvania

ROWING has been a competitive sport for centuries, but the racing shells of to-day have been developed during the past 100 years from various types of racing boats. In this article we will outline some of the developments in rowing equipment which have taken place since the days of the racing boats, the laboratory methods for determining the power required to propel racing shells, and the application of laboratory data to regatta data for the purpose of determining the work done by oarsmen under racing conditions.

The developments in hull design have been progressive and have occurred in logical sequence. The first were introduced by English boat builders, but later others were introduced by American boat builders. The primary object of the improvements was to increase propulsive efficiency and by this means obtain higher racing speeds.

It may be of interest to trace the transformation of the racing boats used in England about 100 years ago into the racing shells of to-day. The racing boats were about 35 feet long, six feet beam, and weighed about 700 pounds. The first development was the outrigger used by Anthony Brown, at Ouseborn on the River Tyne in 1828, a device to support the thole pins—later on the rowlock-outboard of the boat instead of on the gunwale. The second development was the reduction in the beam of the boat made possible by the outrigger.

The reduction in beam led to a study of hull design in relation to stability, structural strength, and method of construction, which has resulted in a very much improved form and reduction in weight of hull. The view was held, and correctly, that by reducing the hull weight without sacrificing structural strength, the racing speed could be increased for a given power application. The designs in use to-day and the materials at present available provide racing shells which will withstand the severe strains developed under racing conditions, and which are of minimum weight.



Wide World

NEW TYPE OF SHELL

Walter Hoover, famous single scull oarsman, testing a new shell made for the United States Naval Academy. It is constructed of duralumin, is 26 feet long, and weighs only 26 pounds

The merits of the outrigger were not immediately recognized and it was 18 years after its introduction in 1828 that Cambridge and Oxford rowed their first race in outrigged boats. About 1860 the eight-oared outrigged boat without external keel, closely resembling the racing shell of to-day, came into general use.

While developments in hull design were in progress, thoughtful consideration was being given to ways and means for improving oar design, and in 1842 the curved blade or "spoon" oar was first used in boat races. The proper dimensions of the oar for supporting the severe loads applied under racing conditions have since been determined and the result is a reduction in oar weight.

One other important subject studied along with the others is the equipment which has to do with the oarsman's comfort and which enables him to apply power to the oar most effectively. This equipment includes the foot stretchers—made adjustable to meet vari-

WORK DONE BY A SINGLE SCULLER
ON
SCHUYLKILL RIVER COURSE, PHILA, PA.
REGATTAS
1922 TO 1926 INCLUSIVE

Event	Number Races	Time Min.	Time Sec.	Miles per Hour	Feet per Min.	Resistance lbs.	Ft-lbs per Min.	% Horse Power
1/4 Mi. Dash	18	1	19	11.36	1000	17.5	17500	.537
				DISTANCE 1 MILE X				
Junior	2	6	43	8.61	775	10.7	8300	25.2
" 1926	1	6	36	9.09	800	11.3	9000	27.3
Intermed.	2	7	2	8.19	720	9.3	6700	20.3
Assoc.	2	6	50	8.78	773	10.6	8200	24.8
Senior Y	2	7	8	8.41	741	9.8	7300	22.1
" 1926	1	7	7	8.42	742	9.8	7300	22.1
				DISTANCE 1¼ MILES				
Junior	7Z	8	12	9.15	806	11.5	9200	27.9
" 1926	–	–	–	–	–	–	–	–
Intermed.	11	8	10	9.06	798	11.2	8900	27.0
Assoc.	13	8	0	9.38	825	12.0	9900	30.0
Senior	14	7	43	9.72	855	12.8	10900	33.0
" 1926	5	7	37	9.84	866	13.1	11300	34.2
				DISTANCE 1 5/16 MILES Z				
2nd Single	4	8	48	8.96	817	11.5	9400	28.1
1st "	4	8	30	9.26	815	11.7	9500	28.8

X 1923 and 1926
Y 1926 Strong head wind
Z 1923 to 1926 Inc.

FIGURE 1

ous leg requirements—to which the oarsman's feet are secured, and the sliding seat, developed in 1870 by G. C. Babcock, Nassau Boat Club, New York, which adds the leg drive to the body swing of the fixed seat, thus providing a very satisfactory means for effectively applying all the oarsman's power. The seats are fitted with rollers of an almost frictionless type, placed on tracks which limit the travel of the seat to a fore and aft direction. The tracks are of suitable length to meet the leg-drive requirements.

The modern racing shell is therefore a highly developed racing device with high propulsive efficiency and a corresponding high racing speed.

THERE has been considerable discussion on the characteristics of a hull of least resistance with a view to increasing racing speeds. Hull characteristics in relation to resistance is a subject which has interested the navy departments of many governments in the design of naval vessels and shipbuilders in the design of merchant ships. An early method was to tow a model and measure the resistances corresponding to different speeds, but such a method was subject to errors in observing tide, wind, distance, and time of run. Also, favorable weather conditions could not always be had. The need for laboratory facilities for studying the many problems of hull form, resistance, propulsive requirements, and so on became more and more apparent and in time, model basins were built. There are two in this country, one at the Washington Navy Yard, and the other at the University of Michigan.

The determination of the resistance of an eight-oared shell with its crew by the towing method was reported by Professor Yandell Henderson in the article, "The Maximum of Human Power and Its Fuel," April 1925, *The American Journal of Physiology*. However, since those determinations were reported, tests have been made at the model basin at Washington Navy Yard on several single and eight-oared shells. We will briefly review the method of conducting the tests and the equipment employed.

The model basin consists of a tank about 470 feet long, about 42 feet wide, and about 14 feet deep, filled with water. Over it is placed a building arranged to be heated, lighted and ventilated. Tracks located on each side of the tank and extending its full length, support a carriage on which is placed the electrical control equipment to regulate carriage speeds up to 20 knots. There are also instruments on the carriage for determining and recording the experimental data, including one attached to the model under test which registers the resistances corresponding to the various speeds of the model through the water.

The tests of six single shells of different models gave results so nearly alike that the relation between resistance in pounds and speed in miles per hour may be represented by the R-V curve in Figure 3. A curve showing the relation between the work done in foot pounds per minute and speed in miles per hour derived from the R-V curve is the P-V curve of the figure.

The tests of the two eight-oared shells are similarly represented by Figure 4. The curves of Figures 3 and 4 are plotted on cartesian co-ordinates, and those curves are reproduced plotted logarithmically in Figure 5, from which the following exponential equations showing the relation between resistance and power based on speed were deduced:

Eq (1) $R_s = .158\ V_s^{1.935}$

(2) $R_8 = .557\ V_8^{2.012}$

(3) $P_s = 15.8\ V_s^{2.875}$

(4) $P_8 = 55.6\ V_8^{2.956}$

In which:—

R_s = Resistance of single shell in pounds.

R_8 = Resistance of eight-oar shell in pounds.

P_s = Work done in overcoming resistance R_s in foot-pounds per minute.

P_8 = Work done in overcoming resistance R_8 in foot-pounds per minute.

Eq (1) and (2) may be expressed approximately R varies as V^2

Eq (3) and (4) may be expressed approximately P varies as V^3

WE note by the last expression that the power required to increase the speed of a shell by even small amounts at the usual racing speeds is very large.

In order to apply most satisfactorily the curves of Figures 3, 4 and 5 to racing conditions to determine the work done by a crew, it is essential that the races be rowed in still water, that is, water with no current, and a wind velocity of zero, conditions which

WORK DONE BY AN 8-OAR SHELL CREW
ON
SCHUYLKILL RIVER COURSE, PHILA, PA.
REGATTAS
1922 TO 1926 INCLUSIVE

Event	No. Races	Time Min.	Time Sec.	Miles per Hour	Feet per Min.	Resistance lbs.	Ft-lbs per Min.	Ft-lbs per Man	% Horse Power
				DISTANCE 1 MILE X					
Junior	2	5	38	10.66	938	64.8	60800	7600	23.0
Intermed.	9	5	39	10.62	935	64.2	60100	7510	22.8
Senior	2	5	14	11.47	1009	74.0	75400	9420	28.6
				DISTANCE 1¼ MILES					
Junior	13	6	41	11.23	988	71.8	71000	8880	26.9
Intermed.	8	6	37	11.35	998	73.5	73300	9160	27.7
Senior	10	6	35	11.49	1011	75.1	76000	9500	28.8
" 1926	1	6	49	11.01	969	69.0	66700	8340	25.3
				DISTANCE 1 5/16 MILES Z					
Senior	3	7	15	10.92	962	66.7	63400	7930	24.0

X 1923 and 1926
Y 1926
Z 1924 to 1925 Inclusive

FIGURE 2

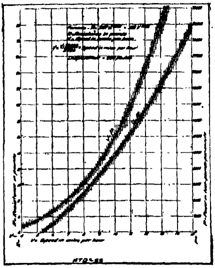


FIGURE 3

are difficult to obtain because most of the regattas are held on rivers.

The regattas held on the Schuylkill River, Philadelphia, for non-college crews are for courses of $1^5/_{16}$, $1\frac{1}{4}$, 1, and $\frac{1}{4}$ mile distances.

The data of these regattas have been compiled for junior, intermediate, association and senior single scullers in Figure 1, and for junior, intermediate and senior eight-oared shell crews in Figure 2. The data for the $1^5/_{16}$-mile course is based on four, the $1\frac{1}{4}$-mile course on 14, and the 1-mile course on two regattas. The speeds given in the figures were computed from the elapsed times between the firing of the starting gun and the finishing gun. The shells are held at the starting buoys to await the starting gun.

The river current varies from almost still water during a drouth to quite rapid after a heavy rainfall, and the wind from zero velocity to quite strong either up, down or across the course. The number of races used to compute the mean time is given in Figures 1 and 2. The data of the $1\frac{1}{4}$-mile course are considered to be the most satisfactory because a greater number of regatta conditions are represented and the oarsmen are probably in the best condition for racing. The American Henley Regatta occurs before the oarsmen have had sufficient time to be thoroughly trained, and the Labor Day Regatta, which closes the rowing season, finds the oarsmen somewhat stale.

WE therefore do not find an increase in the average velocity as the course is shortened from $1^5/_{16}$ miles to 1 mile, so we cannot plot a curve showing the effect of fatigue on speed for the several distances. It is interesting to note, Figures 1 and 2, that the work done by a single sculler and per man in an eight-oared shell crew for the same length course is approximately the same, indicating that the oarsman under the stress of contest gives all the energy he has to expend in the endeavor to win, and that the single sculler expends about $\frac{1}{2}$ horsepower per minute during the quarter-mile dash.

No attempt has been made to compile data on college eight-oared shell crews and apply them to Figures 3, 4 and 5, but their speeds are faster than the non-college crews and the power expenditure would be corre-

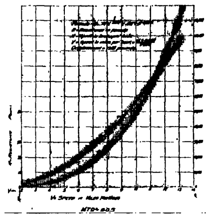


FIGURE 4

spondingly greater as indicated by the expression "P varies as V3."

We may some day be able to determine the velocity of racing shell by means of a Pitot tube and an autographic recording-mechanism similar in principle to installations which have been made on some of our ships. This experimental apparatus should provide a record of the velocity of the shell during the first portion of the race, the slowing down afterward, and the sprint just before the finish, also the velocity changes during the pull and recovery periods of the stroke, and by this means enable us to accurately analyze the power expended by an oarsman.

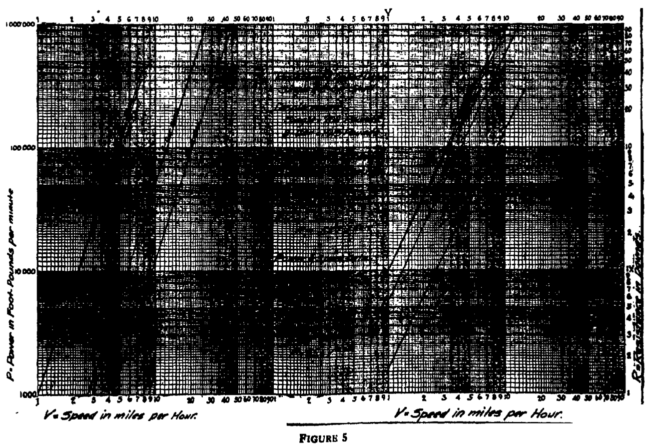


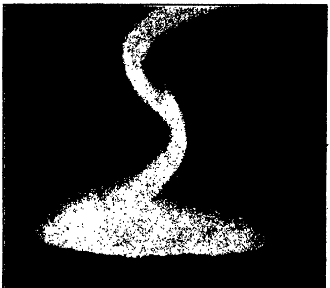
FIGURE 5

From the Scrap-book of Science—


Wide World

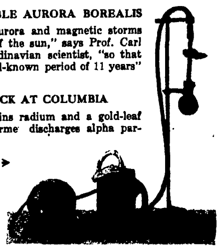
AMATEUR ARCHEOLOGY

Ralph Glidden of California has made a large collection of Indian bones, pottery and stone implements dug from the soil of Catalina and others of the Channel Islands off the coast of that state. His collection is neatly housed in a private museum which seems to be rather compactly furnished with these objects. During the past few years public interest in archeology has increased very greatly and a number of amateurs, often self-trained, have done excellent scientific work of that kind. Increased attention has been given to American archeology, and SCIENTIFIC AMERICAN readers may often help the work by keeping watch of local excavations and reporting to science any finds that they may make


P and A

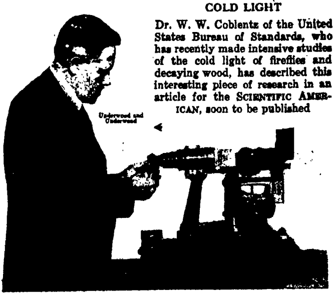
THE INCOMPARABLE AURORA BOREALIS

"The frequency of aurora and magnetic storms follows the activity of the sun," says Prof. Carl Stormer, noted Scandinavian scientist, "so that all three show the well-known period of 11 years" ◄



RADIUM CLOCK AT COLUMBIA

The glass bulb contains radium and a gold-leaf electroscope. The former discharges alpha particles at uniform intervals determined by the pressure, discharging the leaf every few seconds ►


Underwood and Underwood

COLD LIGHT

Dr. W. W. Coblentz of the United States Bureau of Standards, who has recently made intensive studies of the cold light of fireflies and decaying wood, has described this interesting piece of research in an article for the SCIENTIFIC AMERICAN, soon to be published ◄


Ewing Galloway

GENERATORS AT MUSSEL SHOALS

When an engineering job gets into politics, it is liable to assume undue proportions. Mussel Shoals is a big project but not as big as the volume of talk it has occasioned in Congress, in the newspapers and elsewhere

Camera Shots of Scientific Events

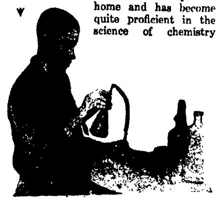
BIG NEW DAM

Two miles below Conowingo, Maryland, work is steadily progressing on the huge, mile-long dam which is to supply hydroelectric power to the city of Philadelphia. When completed it will be second in power capacity only to the Niagara Falls power plants. To construct the dam will require 650,000 cubic yards of concrete. The lake formed in the valley of the Susquehanna River will be 14 miles long. The initial power supplied by the new dam, which will be completed in the autumn of 1928, will be 378,000 horsepower. In time this will be increased to 594,000 horsepower, which would make it the largest hydro-electric power plant in the United States or Canada

Wide World

BLIND SCOUT CHEMIST

Clifford Walker, thirteen, of Atlanta, Georgia, who recently passed the exacting tests required to qualify as a Scout of the First Class, has a chemical laboratory in his home and has become quite proficient in the science of chemistry



P and A

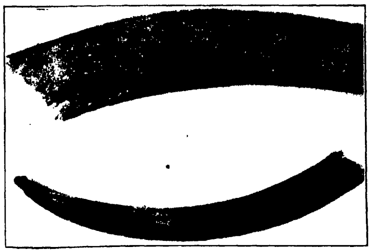
MERMEN

Special life - saving suits have been issued to some of the harbor firemen of Los Angeles to help them in their work which often requires that they get into the water; sometimes they accidentally fall into it. Suits of this kind keep them dry and warm so that they do not have to stop work or run the risk of serious illness due to exposure

Underwood and Underwood

LIVING FOSSIL BIRD

A "living fossil" in the shape of a bird from Madagascar has recently been given to the Smithsonian Institution by Mr. B. H. Swales, of its staff. The bird is the mesite, called also the roatelo, a curious archaic species with no near living relatives, seemingly a survival of earlier periods in the age of the earth which has hung on long after its contemporaries have become extinct. The hoazin is another "living fossil" bird



Wide World

MAMMOTH'S TUSKS CARVED BY ANCIENT MAN

Recently in Czechoslovakia, archeologists discovered a great "cemetery" of mammoths. The bones of many of these extinct elephants were found on a bed of ashes, indicating that prehistoric man had feasted on mammoth meat. The carved tusks shown belong to the early part of the Cro-Magnon period, 20,000 years ago

Inventions New and Interesting

"NIBBLING" SHEET METAL

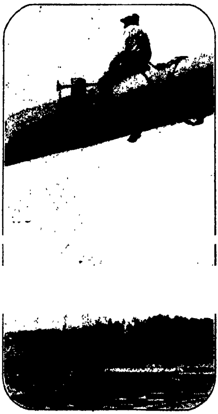
The newly developed machine illustrated above is designed for cutting intricate parts from sheet metal, bakelite and the like. It does away with the old method of drilling the pattern and then grinding to the line. The operator of the machine can govern the direction of the cutting while the mechanism is working

THE CUTTING TOOL

A close-up view of the cutter that is employed in the "nibbling" machine illustrated at the left. The work is guided under the reciprocating cutter

BANDAGE CUTTER

Bandages are made in long rolls and then cut to the required length. The machine illustrated above performs the cutting in a sanitary way and makes a clean cut. The sharp rotating blade does not ravel the gauze

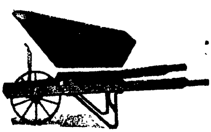


SAFETY STRAP

Men working on horizontal pipes, painting or repairing them, are likely to slip off, with disastrous results. To prevent such happenings, the safety strap illustrated above is in use at the plants of the Ford Motor Company. A circular belt surrounds the pipe and fastens to the belt around the man's waist. It will hold the man suspended until assistance arrives

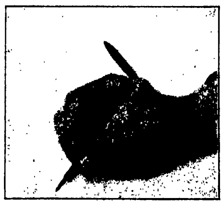
ELECTRIC TRUCK

This small yet powerful truck can be loaded easily and, because of its construction, it can be steered rapidly about a shop without any difficulty



WHEELBARROW

The tray of this wheelbarrow is demountable, allowing the use of any one of 18 different trays, according to the job to be done. A novel arrangement holds the tray firmly in place



A REAL "PEN-KNIFE"

This combination fountain pen and small knife will find many uses when carried by anyone requiring the aid of either of the illustrated units. Both are well built and serviceable

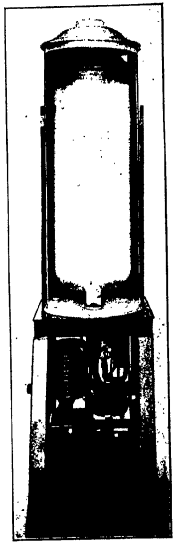
Household Inventions

Iceless Refrigerators Are the Latest Boon to Housewives

CONDUCTED BY ALBERT A. HOPKINS

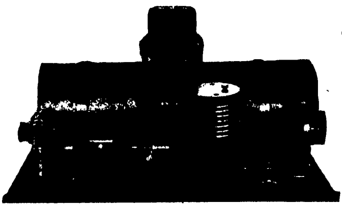
SILENT ICEMAN

"Silent as the Arctic" would be a good slogan for this iceless refrigerator in which no power machinery is used. It is operated by gas which serves to actuate a dry absorption process, circulating the refrigerant by heat. Oiling and cleaning of machinery is thus eliminated



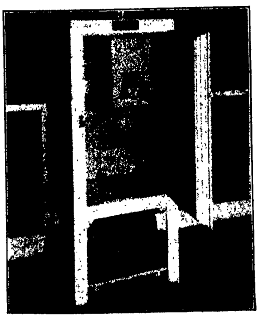
HEAT FOR COLD

The operation of this device depends on the use of a special dry absorbent material with a great affinity for ammonia gas, which it will hold in storage as long as it remains cool. When heated distillation takes place, ammonia gas is driven out, condensed to liquid and evaporated during the freezing cycle



ICE BY WIRE

The absorption system can be operated by electric heat as well as gas heat; the principle is the same. Electricity is available in many places where there is no gas supply and the results are equally dependable. During the change of state of the ammonia from liquid to gas, heat is absorbed from the surrounding materials and carried away by the ammonia gas



FOOD PRESERVER

Those who have ever had a householdrefrigeratingplant will never return to ice. The food is so much better preserved that the purchase expense is soon absorbed by the saving in food. Handy little ice cubes also are made for beverage purposes

THREE IN ONE

Here we have a great kitchen trinity — kitchen cabinet, electric stove and electric refrigerator. A gas stove may be substituted for the electric stove. Everything is so well insulated that the electric refrigerator functions without being affected by the heat being generated in the stove above

The Scientific American Digest

A Review of the Newest Developments in Science, Industry and Engineering

CONDUCTED BY ALBERT G. INGALLS

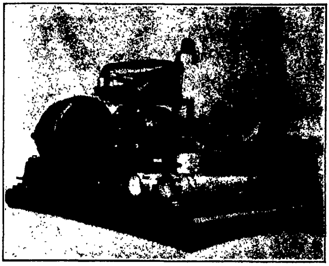
New Chemical Element Obtained in Pure Form

RHENIUM, the chemical element whose discovery was recently announced by Doctors Walter and Ida Noddack, has now been obtained in pure form. The first discovery was based on the finding of the characteristic lines in the X-ray spectrum as detected by photographic plates. Now the Noddacks have succeeded in obtaining, after long and difficult refining processes, a small quantity of the substance itself. They describe it as a black powder of high melting-point, that unites readily with a number of other elements. In an atmosphere of pure oxygen it ignites, forming a white oxide. The quantity so far obtained is very minute, only two milligrams, or seven one-hundred thousandths of an ounce. The experimenters are now at work to elaborate more of it which will permit of exact quantitative chemical examination.—*Science Service.*

Anti-Evolution Legislators Hail from Backward Counties

"IT has been observed," says Dr. Roland M. Harper, well-known Southern botanist and sociologist, writing in the *Daily Science News Bulletin,* "that the authors and supporters of anti-evolution bills which have been introduced in several state legislatures in the last few years (and passed in two or three) generally hail from some of the more "backward" counties; and on the assumption that such legislators reflect the views of their constituents, the writer has made a statistical study of the population of such counties in 14 states, ranging from Delaware to Florida, North Dakota and California. In some states, two or three counties are involved, on account of anti-evolution bills having been sponsored by two or more members, or in different years. The statistics are based on the white population only, for other races are not known to have taken any part in the controversy.

"It is found that the anti-evolution counties, taken together, rank below the combined averages of the same states, and still more below the United States average. For instance, the 1920 illiteracy figures for adult whites in Tennessee are 9 percent for the state as a whole, but 26.6 percent for Macon county, the home of the author of the law that started the famous Dayton trial."



new mercury-vapor detector. Selenium sulfide applied to paper, blackens when exposed to the fumes. The apparatus draws a strip of this paper over an opening through which air flows. Light shines through the paper strip in amounts depending on the blackening, and reaches a photo-electric cell. The detector is then read directly from an ammeter

387,590 Pounds Heavy

THE Bethlehem Steel Company, at its Bethlehem, Pennsylvania, plant, has just completed an extraordinarily large ingot-mould for casting ingots which will be used in making large forgings. This casting, as poured, weighed 387,590 pounds. The length of the casting is 15¼ feet; its width measured across the corrugations at the top of the mould is nine feet. The ingot produced from this mould, a picture of which appears in these columns, will weigh 247 tons.

A mammoth casting made in Bethlehem, Pennsylvania. It is a mould in which ingots will later be cast. Its overall size may be noted by comparison with the figure of a workman who may be seen standing to the right of it. Internally it is large enough to hold a cast ingot which will weigh 494,000 pounds. Alone its weight is 387,590 pounds

New Way to Detect Poison Mercury-Vapor in the Air

MERCURY is from many viewpoints a very interesting substance. Its most distinctive property perhaps is that it is the only metal which is liquid at room temperature, says Birger W. Nordlander of the Research Laboratory of the General Electric Company at Schenectady, New York, the inventor of a new method of detecting poison mercury-vapor in the air. "Even at this temperature it has a noticeable vapor pressure which rapidly increases with the temperature. Owing to this, vapor will constantly be given off from the metal and evaporate into the room where the metal is confined. If, therefore, mercury is spilled out on the floor or left in open dishes, there will always be a certain amount of mercury vapor in the air of the room. Even in high concentration the vapor has no color or odor, therefore it cannot be distinguished by the senses.

"Another interesting property of mercury," continues Mr. Nordlander, "is that it combines readily with most metals to form amalgams, of which those with silver are extensively used as fillings in dentistry. The incandescent vapor of mercury is rich in ultra-violet rays which have found wide use in therapy. Mercury has a remarkable combining power with organic substances like proteins, albuminoids, and fats. Closely related to this property is the physiological fact that the metal and most of its compounds are toxic poison.

"Due to the specific properties of mercury and its compounds, they have found many uses in the industries, such as amalgamation, electro-chemical manufacturing processes, explosive manufacture, catalysis, medicine, dentistry, electrical

apparatus, (such as rectifiers and lamps), manufacture of certain dyes, wool and fur dyeing, carotting of fur, etching of metals, heating operations, in physico-chemical apparatus like pumps, barometers, thermometers, et cetera.

"The recent development of the mercury-vapor process for generation of power, by which a considerable improvement in fuel economy is made possible, has opened up a new field for the use of mercury, which, if extensively applied, would require perhaps five million pounds per year. [Note: Mr. Nordlander here refers to Dr. Emmet's mercury-vapor boiler and turbine unit which is installed at Hartford, Connecticut, where it develops at high efficiency 10,000 kilowatts of energy. A drawing of this interesting unit is reproduced in these columns.—the Editor.] This would necessitate increasing by 70 percent the present world production and would therefore by far outweigh any other application of mercury in importance. For a safe and economical operation of this process, it is necessary that there should be no leakage, since mercury is both poisonous and costly.

"Although the possibility of mercury escaping into the boiler room is practically eliminated by a special design in which all parts containing mercury are enclosed either in the flue or in a housing through which the air for combustion is drawn, thus insuring the discharge of any leaking vapor outside of the building, nevertheless, it was realized that the public demand for safety would require a method by which a constant watch and recording of the mercury-vapor content of the air in the boiler room could be made. It was also of utmost importance to be able to get a continuous record of the mercury-vapor content in the flue gases.

"None of the existing methods were applicable since they all are cumbersome and demand considerable time and skill. Research was therefore undertaken which has resulted in a new indicator of extremely high sensitivity for mercury vapor, and a method has been developed which gives quick results and does not require chemical training to carry out.

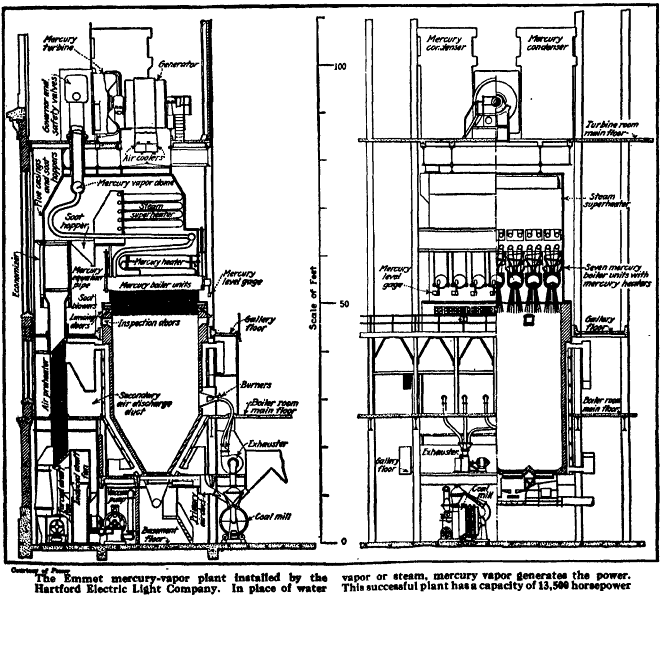
"Briefly, it was found that mercury vapor would react with freshly melted and cooled sulfur to form the black sulfide. This sulfur showed a fair sensitivity which, however, disappeared entirely after a few days. It was evident from this that the reactivity was confined to one of the unstable forms of the element. It developed that this active form could be stabilized by combining it with selenium, an element closely resembling sulfur, and ultimately it was found that a compound of the two, with the chemical formula SeS_2, selenium sulfide, possessed the highest sensitivity to mercury vapor, being about 200 times as sensitive as the most active sulfur.

"On exposure to air containing mercury vapor, paper coated with this chemical is blackened, due to the formation of the mercuric sulfide and selenide. It is possible to use this relationship to make up a color scale for the quantitative estimation of mercury vapor, and by which almost any concentration can be determined. For reasons in connection with the testing of the flue gases from the mercury boiler, a temperature of 70 degrees, Centigrade, and a velocity of one meter per second have been chosen as standard conditions for the test. The sensitivity of the indicator under these conditions is such that by changing the time of exposure anywhere from eight minutes to one minute, any concentration between 1 in 8,000,000 to around 1 in 15,000 (by volume) can be estimated by comparison with the standard color chart.

"A portable apparatus has been worked out by which the standard conditions of the test can be maintained constant. By means of this, it is now possible to determine the mercury-vapor concentration in any desired locality. The operation of the apparatus is extremely simple and does not require any training or skill. For a continuous and automatic registration of the vapor content, a type has been developed by which a record for a whole day can be obtained.

"The latter type of apparatus has been installed at a commercial installation of the

(Continued on page 266)

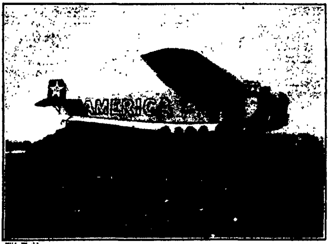


Courtesy of Power

The Emmet mercury-vapor plant installed by the Hartford Electric Light Company. In place of water vapor or steam, mercury vapor generates the power. This successful plant has a capacity of 13,500 horsepower

Learning To Use Our Wings

This Department Will Keep Our Readers Informed of the Latest Facts About Airplanes and Airships



Wide World

Poised on its inclined runway, ready for flight, the "America" waited the advent of propitious weather

Wide World

The crew of the "America." Left to right: Acosta, Commander Byrd, Noville and Balchen of Norwegian navy

Byrd and the "America"

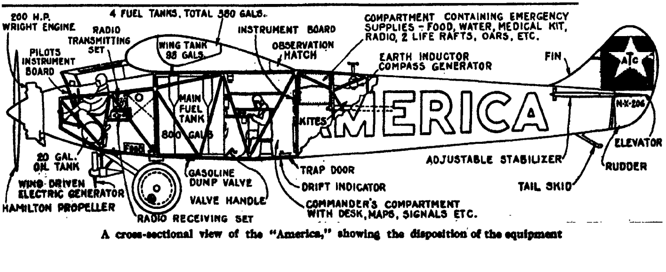
EACH of the three recent flights to Europe has its own special distinction. That of Lindbergh stands out preeminently because he went absolutely alone, and hit his objective, Paris, "squarely on the nose." Chamberlin will be remembered as the first man to carry a passenger to Europe and, at the same time to break the long-distance record. Long before he made his flight, Commander Byrd claimed that he was seeking scientific results, particularly in regard to weather conditions over the Atlantic, and there is no doubt he brought back with him to America data which will be helpful to transatlantic air voyagers of the future.

It is safe to say that, of the three planes that have made the transatlantic trip, the big three-engined Fokker monoplane which Byrd used most nearly approached the type which will be developed in the future for transatlantic flying. The *America* is a stately and handsome machine, and can be picked out of any group of planes in the air, because of its remarkable stability fore and aft and laterally, which the big Fokker monoplanes invariably exhibit. Another excellent feature is that these planes are aerodynamically so perfectly designed that they have an inherent ability to straighten out instead of falling into a nose dive when the ship approaches the stalling speed. On looking at the longitudinal section of the plane, one is struck with the great depth of the wing and its very blunt forward edge. Wind-tunnel experiments have shown that this is a most efficient wing for any but high racing speeds and it is a well-proved fact that in a wing of this type, only 25 to 30 percent of the lift of the wing is due to air pressure against its lower surface, and the other 70 to 75 percent is due to the negative air pressure, or suction, as it is popularly called, on the upper side of the wing.

The graceful appearance of the *America* has not been gained at any sacrifice of strength. A stout metal truss extends from the nose through the body of the machine, and this served to good purpose when the heavy plane made its forced landing in the sea, under the skillful handling of Lieutenant Balchen. In the nose of the fuselage is mounted one of the famous 200-horsepower, air-cooled Wright engines—the other two engines of the same make being carried in special mounts on each side of the fuselage.

Our line drawing, for which we are indebted to the *Aero Digest*, is so complete that there is no necessity to elaborate upon the data there given. We draw attention to the large main fuel tank, which can be emptied and then tightly closed, thereby affording large additional buoyancy in the event of forced descent upon the sea. Note also the radio transmitting and receiving sets in the forward compartment; the spacious commander's compartment immediately behind the main fuel tank; and the all-important generator and earth inductor compass which served Commander Byrd so well until, for some unaccountable reason, it was thrown out of gear over the French coast.

(*Continued on page* 258)



A cross-sectional view of the "America," showing the disposition of the equipment

MORE than a million motorists are now enjoying the benefits of high compression through Ethyl Gasoline. In two ways:

1 *Through high compression automobiles.* The advent of Ethyl Gasoline has at last given car manufacturers the opportunity mechanically to raise the compression of their engines. For cars now in use they can offer special high compression cylinder heads which greatly increase performance.

2 *Through carbon formation.* By letting carbon form in the cylinders of a car of ordinary compression, you automatically increase compression. And since Ethyl Gasoline is a high compression fuel, those deposits which heretofore have meant "knocking" and power loss become a source of *extra* power and driving satisfaction.

Ethyl Gasoline is motor gasoline containing Ethyl brand of anti-knock compound, the ingredient which eliminates the "knocking" characteristics of ordinary gasoline and makes it a high compression fuel.

In terms of you and your car, high compression and Ethyl Gasoline mean a more powerful and flexible car, less gear-shifting, faster pick-up, less vibration and lessened depreciation. In short, a performance and economy impossible with ordinary compression and ordinary gasoline.

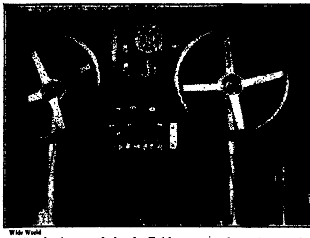
Ethyl Gasoline is distributed in the United States and Canada by responsible oil companies. *It has absolutely no ill effect on the motor or its parts.*

The first tankful will prove every claim. On sale at pumps which bear the "ETHYL" trademark shown on this page. There's one near you.

ETHYL GASOLINE CORPORATION
25 Broadway, New York City

ETHYL GASOLINE

P and A



Wide World

The dual controls in the Fokker monoplane that made the Hawaii flight. Each pilot has a view of the instruments and has his own controls of the plane

Commander Byrd's articles descriptive of his flight, which appeared in the public press, are so complete and clear that it is sufficient, just here, to touch only on some of the outstanding features. He was in the air for a total of 43 hours, during which he estimates that the *America* traveled about 4200 miles. Of the three recent trips, it is evident that, so far as weather conditions are concerned, the *America* had the most difficult and strenuous time. The trip from New York to Newfoundland was made under rather trying conditions. Byrd had scarcely left Newfoundland before he ran into the prevailing fogs above the Newfoundland banks, and he tells us that for 19 hours of his transatlantic passage he had no sight either of land or of water, being completely surrounded by dense, impenetrable fog.

Acting on the meteorlogical data furnished by the Weather Bureau, he rose to a height of 10,000 feet in order to get above the fog banks and the clouds and veered somewhat from his intended course so as to avoid the storm and secure the advantage of a favorable wind upon its outer fringe. The wind seemed to have been with him during a large part of his trip above the Atlantic. He steered for Finisterre and was successful in making it; but here he ran into extremely bad weather, dense clouds, fogs and heavy rainstorms, and at this critical moment his best friend, the earth inductor compass, failed to function.

He believes that he reached Paris; but so thick was the weather that he had no sight even of the powerful searchlights or of the rockets which were sent up from the Bourget field to aid him. He was over Paris with sufficient fuel for another 300 miles of travel, but in his graphic story in the *New York Times*, he says, "We must have been near Paris twice in the five hours of venturing, in pitch darkness, with the rain pouring." At this point, with the young Norwegian flyer, Balchen, at the wheel, he decided to return to the coast and take the least risk of landing upon the water. This he did near the little village of Ver-sur-Mer, where, guided by the flash of the lighhouse, Balchen brought the ship down. The landing gear was stripped as it struck the water 200 feet from the beach, but the four men, Commander Byrd, Noville, Acosta and Balchen reached shore by inflating the emergency raft and sustained no more serious injuries than shock, bruises, and in the case of Acosta, a fractured shoulder blade.

The Flight to Honolulu

ALTHOUGH an airplane flight from San Francisco to Honolulu does not compare either in distance or difficulty with a flight from New York to Paris, the recent exploit of the two army officers, Lieutenants Maitland and Hegenberger, is a highly meritorious performance. The distance covered was 2300 miles as against about 3600 miles to Paris, and the weather was certainly more propitious than that encountered by the transatlantic flyers. The plane used was a tri-motored Fokker monoplane, practically identical with that used by Commander Byrd.

There was one respect, however, in which these army flyers were confronted with a far more perilous and perplexing task than that of flying the Atlantic. We refer to the fact that the group of Hawaiian Islands covers so little space in a north and south direction, or normal to the line of flight, that on the map it looks not much larger than the head of a pin. Hence, whereas the Atlantic flyers had a thousand-mile stretch of continent to aim at, the transpacific flyers must hit a baseline a few miles in extent or, missing the islands, drive fruitlessly into the unknown wastes of the Pacific, until they fall exhausted into the sea. As it turned out, the navigation was magnificent, and our gallant fliers struck the islands "squarely on the nose."

With that admirable modesty which, it seems, invariably characterizes the officer personnel of our army, these young lieutenants attributed their success to the splendid army organization and the great care with which the equipment, both of the machine itself and of the aids to navigation, was prepared before the start was made.

The story of the flight, as so admirably told by the fliers, Maitland and Hegenberger, in the *New York Times*, is replete with interest and rich in technical data. The Fokker monoplane, specially strengthened as the result of preliminary tests, weighed empty 6600 pounds, and 14,000 pounds as it left the ground. It is explained that the flight was decided upon long before any prizes were offered for such a flight. The venture was a strictly military one, and had as its objective the linking of the mainland with our island territory. Of particular importance was the new radio beacon, one of which was erected at San Francisco, and the other on the island of Maui. These beacons were to signal the course; the flyers catching the signals would be able to check their position relative to the direct course as laid out.

The heavily-loaded plane left the ground after a run of about 3200 feet and passed the Golden Gate at a level of 2000 feet. The method of determining drift by dropping smoke bombs was abandoned because, with the morning light in their eyes, it was impossible to take accurate sights; instead use was made of the spurre left on the water by passing waves, which was sighted through the floor of the cockpit. The radio-beacon signals were picked up, and proved that they were on their course, but after they had been out one hour, the signals ceased, and at the same time, the important inductor compass failed to function. Then clouds were encountered, and in order to obtain drift measurements through observation of the sea surface, it was necessary to drop down from about 3000 feet to 300 feet, at which level they flew for the rest of the day. Another attempt was made with smoke bombs, but the air was "bumpy" and the tail of the plane waved to such an extent as to prevent accurate observations.

At 300 miles out, the first observation of the sun was obtained, and by tables prepared in advance, the flyers were able quickly to determine their position. Early in the day, the *Chateau-Thierry* was sighted, at about half-past two another ship, the *Soloma*, and later in the day the *President Cleveland*. Radio communication was established with these ships, and from them the position of the plane was determined. Darkness was coming on, accompanied by thicker and deeper clouds; so they climbed above the clouds to 10,000 feet for celestial observations. Here the temperature was extremely low and frost was affecting the carburetor of the center engine, which slowed down and caused the plane to settle slowly to 3000 feet.

In the warmer temperature, the frost thawed out, the center engine picked up, and they climbed back to 7000 feet where they obtained further celestial observations. Finding that they were ahead of their schedule, and wishing to land by daylight they throttled their engines down to half speed, and made for the island of Kouai, which was sighted at 6 A.M. They now circled Kouai and finally, driving ahead at full speed, crossed Kouai channel and made an easy landing on Wheeler Field, dropping down at the north end of the field.

Radio Notes

A Monthly Review of Progress in Wireless Communication

CONDUCTED BY ORRIN E. DUNLAP, Jr.

C. R. Hanna, one of the inventors of the loudspeaker known as the "exponential horn," developed in the Westinghouse laboratories. When tested in Pittsburgh, the sounds from the reproducer were clearly heard three miles away. The reproducer unit is shown here in the foreground

An "Exponential Horn"

A NEW invention called the "exponential horn," which is said to hurl the natural voice or tones of music across a distance of a mile without distortion, has been demonstrated by the Westinghouse Electric and Manufacturing Company.

The music of famous bands, orchestras, singers and choirs was reproduced through the new horn by means of a phonograph from the Westinghouse Building. Listeners three quarters of a mile away heard floating over the valley the lowest tones of the organ and bass horns and the shrillest tones of the piccolo, in perfect harmony and clearness. They heard a recitation of Kipling's "Boots" and "Gunga Din" by phonograph distinctly and naturally.

The new horn is the invention of Clinton R. Hanna and Dr. Joseph Slepian of Pittsburgh. They have obtained a patent on the horn and expect to have it put on a commercial basis.

The secret of the volume lies in a mathematically precise enlargement of the tone chamber so as to allow the tone sounds to "get a grip on the air." The volume and clarity are due to the construction of a tone chamber four feet deep and one foot wide. The inner nature is the secret of Dr. Slepian and Mr. Hanna. However, other engineers said the tonal chamber possibly was constructed with shafts, so that there was little need of amplification or "push" to put the sound waves on the air. When amplification or electrical energy is employed, there always is distortion, according to engineers.

The exponential horn is four feet square, yet it operates on less electrical energy than is required to operate the ordinary radio loudspeaker.

Colvin K. Lee, general engineer of the Westinghouse Company, explained the principle of the exponential horn by comparing its operation to cupping the hands at the mouth and calling out loudly, as in a quarry or a glen. The sound is not qualified but is given impetus on natural sound waves so that it is carried for a great distance.

New Tube Works on Alternating Current

A RADIO vacuum tube designed to take its filament and plate power from either direct or alternating current of 110-volt mains without changes in the wiring of the set has been introduced in New York by Dr. Frederick W. Zons, the inventor. It was pointed out that heretofore almost without exception radio tubes have been constructed to operate from a source of reduced voltage, such as the output of a small transformer.

The size of the Zons tube is such that it can be utilized without change, wherever general-purpose receiving tubes of the six-volt type are used. It fits the standard sockets. The house current, either alternating or direct, is led by specially designed connectors directly to two terminals at the top of the bakelite base of the tube, which are connected to the two interior heating elements. These heaters are not connected metallically to the receiver circuit.

Heat generated in the two heater elements is given off to a thimble of nickel which is coated with oxides that emit large quantities of electrons when the proper operating temperature is reached. This thimble corresponds to the filament in the ordinary receiving tube. A connection is made from the thimble to the two "A" battery terminals of the standard base, forming the grid-return connection to the receiver. It is this method of connection that makes the new tube applicable to any receiver without any changes in wiring, according to the inventor. The other elements within the tube are the customary grid and plate.

The heating elements consist of small tungsten wire coils, wound on refractory tubes. According to Dr. Zons the heaters are designed to safely withstand voltages 100 percent in excess of voltages supplied by ordinary lighting circuits.

(*Continued on page* 271)

The model of the *Santa Maria*, built by Karl Bauer of New York, serves as the cabinet for a radio set. Violin wood was used in the construction. The sails serve to reflect the sounds from a small loudspeaker within

INDUSTRIES FROM ATOMS

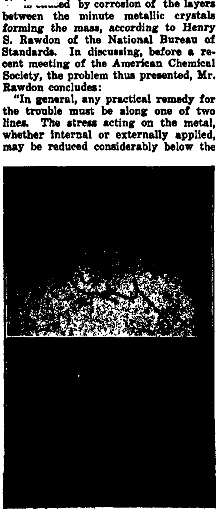
A Department Devoted to the Advancements Made in Industrial and Experimental Chemistry

CONDUCTED BY D. H. KILLEFFER

Intercrystalline Corrosion of Metals

FREQUENTLY the failure of metals ... ...ed by corrosion of the layers between the minute metallic crystals *forming the mass*, according to Henry S. Rawdon of the National Bureau of Standards. In discussing, before a recent meeting of the American Chemical Society, the problem thus presented, Mr. Rawdon concludes:

"In general, any practical remedy for the trouble must be along one of two lines. The stress acting on the metal, whether internal or externally applied, may be reduced considerably below the yield point of the metal. Most of the short-time laboratory tests have shown that in order to produce failure within a reasonable time in the laboratory, the metal must be stressed close to its yield point. The practical solution of the problem of corrosion cracking in wrought brasses and other copper alloys has been along this line. The ot... reduce the corrosive attack either by protective coatings, as in the case of duralumin, or by preventing so far as possible the formation and accumulation of the corrosive solution, as in the treatment for the prevention of "caustic embrittlement" of boiler plate. There appears also to be a possible third solution applicable in certain cases, which depends upon a change in the structural conditions in the alloy, particularly as related to the grain boundaries, by suitable heat treatment or possibly other processes."



Photomicrographs of mild-steel boiler plate, magnified 250 times, showing cracks, or "caustic embrittlement"

Tear Gas as a Fumigant

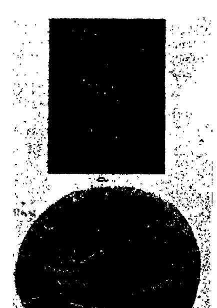
THE weapons of chemical warfare are being more and more widely applied to peace time problems, and the latest investigation of this subject has been conducted by Hoyt and Ellenberger of the Larkin Company, Buffalo, New York. These investigators have studied the effects of chloropicrin, a well known tear gas, when used for fumigating foodstuffs. The conclusions of their researches, as reported in *Industrial and Engineering Chemistry*, follow:

"Food products exposed to commercial fumigations with chloropicrin were apparently undamaged in any way. The foods tested included (1) flour, cocoa, macaroni, rolled oats in paper bags, and lard and butter in one-pound cartons exposed one week to a concentration of 0.8 pound per 1000 cubic feet; and (2) raisins, prunes, nuts in shell, nut meats, lard, and nut margarin exposed in open containers for one week to a concentration of 1.33 pounds per 1000 cubic feet.

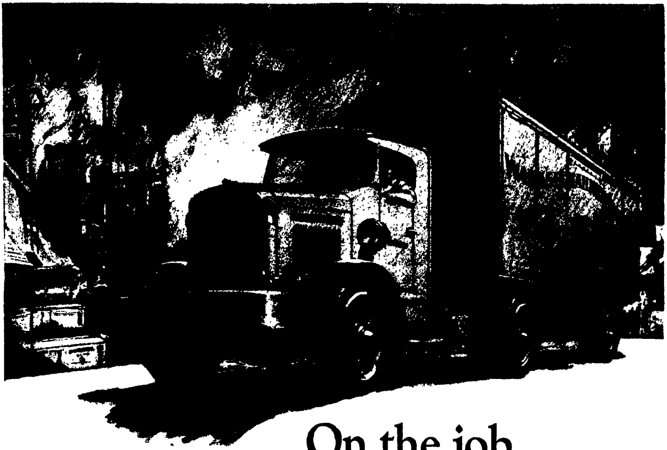
"Germination tests on buckwheat, corn, oats, sunflower, and wheat showed that exposure for one week to a concentration of 0.8 pound of chloropicrin per 1000 cubic feet had no detrimental effect on the germinating power of these seeds, the germinating power of wheat and buckwheat being even somewhat improved thereby.

"It should be emphasized that the limited experience gained from these ... does not warrant ... final conclusions concerning dosages, method of application or effectiveness of chloropicrin against various species of insects. Much additional data on fumigation tests under a variety of practical conditions must be accumulated before chloropicrin can be correctly and properly evaluated as a fumigant. We believe, however, that chloropicrin has great merit as a fumigant, by reason of (1) the protective warning produced by its lachrymatory power in high dilutions, (2) the fact that it appears

(*Continued on page 275*)



Lead, magnified about six times; *a* is pure and *b* is coarse grained metal. Note intercrystalline corrosion



On the job for the Wabash every day

IN the past year the Wabash Railway has further improved its freight service by the installation of International Chain-Drive Trucks and a battery of All-Steel Semi-trailers.

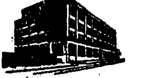
This truck and trailer equipment is operated for the Wabash by the Arthur Dixon Transfer Company, one of the oldest in the country. These trucks and trailers are on the job ten hours every day and they are saving as high as 72 hours per shipment and replacing hundreds of trap cars and line cars every month.

The Wabash is using International Trucks at many points in many capacities and so are all the larger railroads of the country. And that is easy to understand; International Trucks have been giving good service for twenty-three years just as other products of the Harvester Company have been giving good service for almost a century.

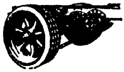
INTERNATIONAL HARVESTER COMPANY
OF AMERICA
606 SO. MICHIGAN AVE. (INCORPORATED) CHICAGO, ILL.

INTERNATIONAL

The International line includes the Special Delivery for loads up to ¾-ton; 4 and 6-cylinder Speed Trucks of 1¼, 1½ and 2-ton sizes; Heavy-Duty Trucks ranging from 2½ to 5-ton sizes; Motor Coaches; and McCormick-Deering Industrial Tractors. Below are given a few points of superior International service and design. Write for folder on Internationals for your business.



International Trucks are served by 136 Company-owned branches in the United States, branches and dealers throughout Canada, and service facilities in foreign countries the world over. The branch illustrated is in Boston, Mass.



The forged steel radius arm includes a convenient chain adjustment. In the heavier models the live axle has a 2-speed range, assuring efficient power transmission in all going.

Herringbone Gears in double reduction drive models assure greater torque capacity and better all-around performance.

All International Trucks are provided with auxiliary rear springs. These springs come into action when needed and assure correct spring flexibility under varying loads. The type illustrated is provided for the double reduction drive Heavy-Duties. Another valuable International feature!

The Steer-Easy steering-gear makes the truck drive as easily as a passenger car, relieving the cramped, tiring position of driver.

Applied Science for the Amateur

A Department Devoted To the Presentation of Useful Ideas Material of Value To All Will Be Found Here

CONDUCTED BY A. P. PECK

Practical, Home Made Surveyor's Instrument

MR. W. T. RHODES, resident engineer of the California Highway Commission on the Yosemite road, has invented a device for cross-sectioning and slope staking, which saves the surveyor's time and labor. It consists of a simple arrangement of scales on a staff or rod, combined in such a manner that distances to a point vertically and horizontally are readily obtained graphically when the slope distance is known by measurement.

This simple surveyor's instrument is light and portable, and can be set up almost instantly. It is very much easier to handle than a transit

On this instrument horizontal and vertical distances, representing respectively the base and altitude of a right-angled triangle, are read from scales on a movable arc turning about a horizontal axis pin at a definite height. The slope distance, which is the hypothenuse of the triangle in the case, is then read on the fixed vertical scale. Turning the arc and sighting at the point whose elevation is desired, determines the vertical angle: this is the principle on which the implement works.

The operation of taking cross-sections consists of setting the instrument on a station or point whose elevation is known. The instrument is first plumbed by means of a rod level attached to the staff. It is then held steady in this position by a man who also holds the tape. The observer sights on the point or rod held by the rodman, who holds the zero end of the tape. The arc is clamped in position and the slope measurement is taken with the tape. Applying the slope measurement to the fixed scale, the observer then reads the vertical and horizontal distances directly from the respective scales on the arc.

The device can be used equally well for original or final cross-sections, setting slope stakes, reference points from center line, or re-establishing the center line from reference points. A three-man party can handle efficiently the work in mountainous and rugged country. The instrument replaces the transit in the method of taking cross sections by slope angles and slope measurements.

Testing Storage-Battery Electrolyte

AT best, storage batteries of the lead plate-acid type are comparatively delicate pieces of equipment, despite their size and great weight. Often it takes only a slight irregularity of the composition of the electrolyte to cause the battery to give unsatisfactory service. In a recent issue of *Power*, Mr. Anthony N. Christopher tells how the electrolyte may be tested by very simple means. Mr. Christopher writes in part as follows:

"Storage-battery equipment of power plants is usually quite expensive and has a comparatively short life. While a slight abuse in charging or discharging is sometimes unavoidable, the worst enemy of a battery is an impure electrolyte. For this reason only pure distilled water and battery sulfuric acid should be used. Water from a faucet may contain traces of minerals. Iron, platinum, copper, nitrates and chlorine in the solution are harmful to the battery in a greater degree than any other impurities, and doubtful water, acid or electrolyte should be tested to determine if it contains any trace of these substances.

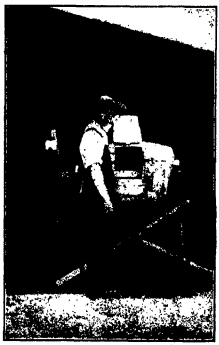
"Iron is one of the chief enemies of the storage battery. To make a test for this metal, neutralize a small amount of the electrolyte with ammonia. Then add an equal amount of hydrogen peroxide and boil. After thus heated, mix with ammonia or caustic potash until the liquid becomes alkaline. The forming of a brownish red precipitate shows the presence of iron in the electrolyte.

"The slightest trace of platinum in the storage-battery solution causes local action, and it is evidenced by gassing of the battery when on open circuit.

"Mercury in itself does no harm in a battery, but it often combines with other metals to cause local action, and if in sufficient quantity, it may amalgamate the plates. To a sample of the electrolyte add lime water. The formation of a black precipitate indicates mercury. Another test for this metal is to add a solution of potassium iodine to the electrolyte. If it contains mercury, an olive-green precipitate will be seen. To a sample of electrolyte add ammonia slowly, and if there is copper in the solution a bluish white precipitate will be obtained."

Controlling Wheat Smut

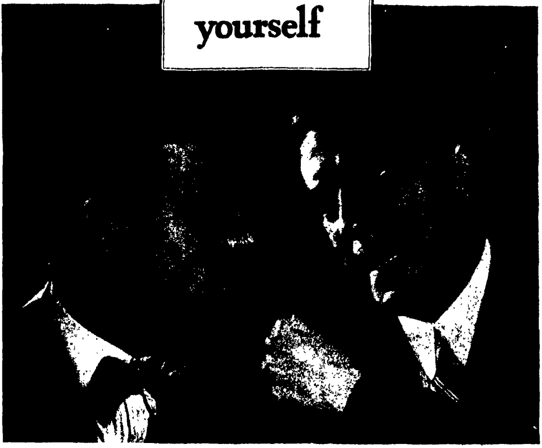
CONTROLLING wheat smut by the use of a home-made device such as the one illustrated is an easy matter. Copper carbonate dust is placed in the barrel and the light, fluffy powder is mixed with the seed wheat so that a light film is applied to every kernel. Inside the barrel is a board



Seed wheat can be quickly treated for smut prevention in this barrel

fastened at right angles so that it can bring about a better mixing of the seed and the dust. The handle is used for turning the barrel until the wheat and the copper carbonate dust have been thoroughly mixed. *Contributed by Allen P. Child.*

don't fool yourself



Decency demands it

Don't fool yourself by thinking that you never have halitosis (unpleasant breath). The worst offenders are usually unaware of it. You, yourself, can never tell.

Therefore, common decency demands that before meeting people, you put yourself on the polite side by the use of Listerine. You simply rinse the mouth.

1/3 Had Halitosis

115 barbers say that about every third man that walks into the shop has halitosis. Who should know better than barbers?

Face to face evidence

Immediately and effectively, Listerine combats unpleasant odors arising from teeth and gums, the most common source of halitosis. And the antiseptic essential oils combat the action of bacteria in the mouth.

Better keep a bottle handy in home and office so that you may never offend.

Lambert Pharmacal Co., St. Louis, U.S.A.

LISTERINE

FALL IN LINE!

Millions are switching to Listerine Tooth Paste because it cleans teeth whiter and in quicker time than ever before. We'll wager you'll like it. Large tube 25c.

The Scientific American Digest

(Continued from page 255)

mercury boiler (Hartford Electric Light Company, Hartford, Connecticut,) to give a permanent record of the mercury-vapor content in the flue gases. It has given very satisfactory service and proved to be a valuable instrument for the control of the condition of the boiler, having made it possible to show that during a long period of tests the leakage of mercury from the boiler is negligible. The sensitivity is such that the introduction of a few drops of mercury into the furnace will immediately be registered distinctly by the recorder.

"In a similar way the concentration of mercury-vapor in the boiler room has been watched, and as expected, it was found to be so low that any danger of poisoning is practically out of the question. In this connection it might be of interest to mention that it was found that if water is poured on top of mercury, the rate of evaporation of the mercury out in the atmosphere is considerably depressed. Wherever mercury is left in open dishes it should, therefore, be covered with water.

"Sometimes in repair jobs, it is necessary to work in places over mercury. Experiments have shown that in such cases commercial gas masks with a canister filling containing activated charcoal, like the Burrell gas mask, are very effective in removing all mercury from the air and therefore in eliminating all danger of inhaling mercury. Since a means of detection of a danger is always a pre-requisite of its control, it thus seems justifiable to hope that the health hazard, as already in the case of the mercury boiler, so eventually in other industries where mercury is used, is in a fair way to be diminished if not quite done away with."

The New Inside-Frosted Electric-Light Bulbs

NOW that electric-light bulbs, frosted on the inside, have become common, many readers are inquiring whether there is not a considerable loss of light, due to the frosted surface. The loss is about 2 percent greater than that in the plain bulb of clear glass. The loss in the case of the old, outside-frosted bulb was from 6 to 8 percent.

Why the old, plain, non-frosted bulbs have been supplanted has been explained by the American Institute of Electrical Engineers in the following manner:

"For many years lamp engineers realized that a lamp frosted on the inside, instead of on the outside, would be very desirable. It would not only present a smooth outside surface and be as easily cleaned as a clear lamp, but a lighter frosting would suffice, increasing the efficiency. The trouble with the idea was, that when a lamp bulb was frosted on the inside, it became as brittle as an egg shell. For 20 years engineers wrestled with this problem to no avail, until Marvin Pipkin, of the General Electric Company at Nela Park, solved the difficulty. The method is simple.

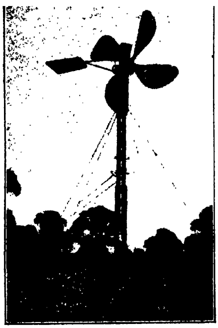
"A strong solution of acid is first sprayed into the bulb, which etches it. In this condition the surface of the glass is made up of irregular little projections with many sharp angles. While the glass is still in this state it is extremely weak, and a slight pressure or

bump is sufficient to shatter it. So far, the process is similar to former attempts at inside frosting. The difference lies in the strengthening process, which is the application of another acid solution, somewhat weaker than the first. This second treating rounds off the sharp edges and minute projections, giving the glass an appearance, under a powerful microscope, of being made up of tiny hemispheres. The bulb is now strong again—just as strong as it was originally.

"Diffusion of the light by the inside frost is obtained by prismatic refraction with comparatively little loss. In fact, the inside frost allows an even greater portion of the light to pass through than does a similar frost on the outside of the lamp. This is due to the fact that the multiple internal reflections are not so numerous in the inside-frosted lamp because the rough, interior surface does not reflect any considerable portion of the light back and forth inside the lamp, as happens with the outside-frosted lamp. Moreover, the relative absorption of the inside frost does not increase so rapidly with the life of the lamp as does that of other diffusing media."

Windmill Power

"THE cost, therefore, of windmill-generated electricity, either for small lighting or for small power purposes, is quite reasonable and such as to justify a wider use." This quotation is from



The ventimotor, one of the several new types of wind-electric power generators made in England

"A Report on the Use of Windmills for the Generation of Electricity, Bulletin Number 1," rendered by the Institute of Agricultural Engineering of the University of Oxford, England, and published by the Oxford University Press, American Branch, New York.

The Institute of Agricultural Engineering at Oxford has been making some unusually exhaustive tests on a number of commercial types of windmill power-generating outfits suitable for farms and similar purposes. No American makes

were tested, as far as the report indicates, but those of our readers who, judging from our mail, take keen interest in the question of windmill power, will doubtless find much information of interest in it, despite the recognized fact that many conditions, both economic and technical, are not the same in America as in England. The report forms a 63-page pamphlet with several excellent plates.

Scientists Find Parent Substance of Vitamin D

THE anti-rachitic vitamin over which dieticians, health authorities and the possessors of young offspring have been so deeply concerned for the last few years, is nearly tracked down to its original source. The younger generation will be interested to know that a preparation many times more potent than cod-liver oil to prevent and cure rickets is ready to be tried out by physicians.

Scientists here and in Europe, working in more or less collaboration on the problem, have come to the same conclusion, says Dr. Alfred F. Hess of the College of Physicians and Surgeons, Columbia University, that the anti-rachitic vitamin D is formed when certain sterols, a group of substances similar to fats, widely distributed in the lower plants, are exposed to ultra-violet light. Both Dr. Hess and Drs. O. Rosenheim and T. A. Webster of the National Institute for Medical Research in London have collaborated with Prof. A. Windaus of Gottingen University in Germany, who has been engaged in research on the chemical problems involved in the isolation of the anti-rachitic vitamin for several years.

About two years ago Dr. Hess reported that cholesterol, occurring in all animal fats and oils, and its counterpart, phytosterol in vegetable foods, after irradiation with ultra-violet light, was the substance actually responsible for preventing rickets. Irradiated cholesterol in very much smaller doses would produce the same results as cod-liver oil, only one millionth of a gram being necessary to protect a rat from rickets.

Now, however, another step in the pursuit of the vitamin has been accomplished. The English workers, as well as Dr. Hess and Prof. Windaus, all believe that it is only a small portion of the cholesterol which is activated by ultra-violet light. This is an allied substance called ergosterol. This compound is widely distributed in lower plant forms and only very minute quantities are needed to protect laboratory animals from rickets.

"It was found," says Dr. Hess, "to bring about a healing process of the bones when even as little as three ten-thousandths of a milligram per capita daily was given. In tests in which irradiated cholesterol is fed, it has been found that approximately one milligram is needed to initiate healing. Other experiments will be undertaken to ascertain the relationship of ergosterol to cholesterol and the extent of its distribution in the animal body."

The practical value of the discovery of this concentrated form lies in the fact that it will be possible now to dispense

liver oil. Hitherto it has been the practice to resort to such general remedies as sunlight and a diet of foods known to contain anti-rachitic elements. A German authority has suggested that one of the consequences of this research will be to put oleomargarine products on an equal basis with butter and cream, for the irradiated oleo will now have the same anti-rachitic constituents as real butter.—*Science Service.*

Vanadium New Member of World's Metal Family

THE addition of a new metal, vanadium, to the world's resources, is announced by J. W. Marden and M. N. Rich, research scientists of the Westinghouse Lamp Company.

Vanadium has been known in its compounds for a long time, according to Drs. Marden and Rich, but in spite of a century of efforts on the part of chemists, no one has previously been able to produce it in its pure form. The method employed by the authors is to heat a mixture of vanadic oxide, metallic calcium and calcium chloride in an electric furnace for an hour at a temperature of nearly 1400 degrees, Fahrenheit. After cooling and stirring the resulting mass in cold water, metallic vanadium is obtained in the form of beads.

"The beads of vanadium are very bright, have a steel-white color and are quite malleable, soft and ductile," say the authors. "They can be melted in a vacuum in a high-frequency induction furnace, rolled into wire and worked up into other shapes. As far as analysis can determine, they are 99.9 percent pure metal.

"There is no known use for this new metal at present, but undoubtedly it will have special properties that will make it useful. Tungsten, for example, was once a useless metal, but is now of inestimable value for filaments in incandescent lamps, for high-speed tool-steel alloys and many other purposes. Vanadium may, in time, prove equally serviceable."—*Science Service.*

Wild Duck Wears Legband Over Twelve Years

THE growing practice of bird banding is revealing surprising instances of the longevity of birds. The United States Biological Survey has recently received a "return record" of a pintail duck treated for duck sickness in Utah by Dr. Alexander Wetmore of the Smithsonian Institution back in September, 1914. The duck was cured and released by Dr. Wetmore after having affixed to it Biological Survey band No. 519. In October, 1926, the bird was shot by H. W. Seybert in California, showing that the band had been carried for over 12 years. Since the duck was a full-grown bird fully a year old when it was released it must have been at least 13 years old when shot.

Scientists commenting on the incident in the ornithological journal, *Condor*, consider it "a most remarkable record in view of the fact that each season it had run the gauntlet of hunters and also had escaped the poisonous alkali areas where many thousands of ducks die annually from duck sickness, and other natural enemies."—*Science Service.*

Radio Notes

(Continued from page 260)

When operating from lighting circuits supplying 110 volts direct current, both "A" and "B" batteries may be eliminated. The 110-volt current is applied directly to the filament of the tube and the same voltage, with a simple filtering device, is utilized to supply the plate voltages required. The tube operates at maximum efficiency at approximately 90 volts plate potential. This makes it impossible to burn out the filament of the tube by short-circuiting the "A" and "B" circuits, as the two voltages are practically equal.

Dr. Zons' laboratory tests are said to indicate that the vacuum and operating characteristics of the tube become more desirable as the tube life increases, principally because the operating temperature of the active oxide on the coated cylinder does not become excessive. This condition is conducive to long tube-life. A receiving demonstration was heard, utilizing a tube that was said to have successfully withstood 220 volts on its filament for several minutes. Tests have also shown that no decrease in signal strength occurs until filament voltages of less than 75 percent of the rated 110 volts are utilized. Fluctuating line voltages, therefore, show practically no undesirable effects.

How Marconi Beam Dodges Sunlight

INVISIBLE shafts of electric power, sweeping across the surface of the earth, with London as the central point of radiation, now encircle the globe in the twinkle of an eye. Picture a great lighthouse in London with a beam sufficiently powerful to sweep around the earth, and that, in effect, is what the Marconi beam system amounts to in its operation between England, Australia and India.

Three masts 260 feet high hold aloft the aerial wires from which the beam is directed to Australia. Five masts 287 feet in height are used for the service to India. The radio reflector, which concentrates the waves in the desired direction as the reflector of a searchlight directs rays of light, consists of 64 vertical wires. The reflector is located behind the aerial at a distance one quarter of the wavelength used. The beam is projected from the aerial system at right angles to the plane of the masts.

It is pointed out by the engineers that, once the message is given the right direction, physical geography plays a leading part in the transmission. They say that when traffic is sent east to Australia, the route of the beam is across north-central Europe, southwestern Asia and India, following the great circle toward the Antipodes—the exact position of which is near the islands of that name southeast of New Zealand.

After shooting out from Grimsby, England, the beam widens until it reaches its maximum width of 16 degrees and then contracts until it strikes Australia. The beam naturally follows the shortest—in this case the eastern—route, which is about 10,500 miles. But transmission is not always easiest by the shortest way, and at sunrise in England the alternative western route—across the Atlantic and Pacific—is used, the distance on the great circle in this case being 13,500 miles.

The operators at the receiving station at Singapore listen for the change and when

fading begins, send a message to the transmitting station at Ballan, near Ballarat, Victoria, to switch over. The change is effected in a fraction of a second. It simply means—as at the Tetley station—the turn of a switch in the transmitting shed. The aerials have been arranged so that one set can be energized for the eastern and one for the western route while the reflector in the middle serves both and concentrates the energy in the desired direction. Two directions and one wavelength are used in the Australian service and two wavelengths and one direction will be used for India.

Despite interruptions from the change of direction, the Australian service operated both ways on the day it was opened for public service at over 100 words per minute for 19 hours, while the contract calls for seven hours only. Signals were audible on that day for 22 hours out of the 24. The wavelength used for Australia is 25.9 meters, while the return service uses 25.7 meters.

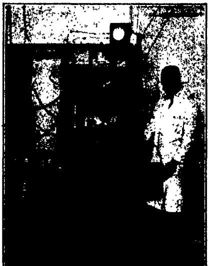
Pictures Enlarged When Received

PHOTOGRAPHS sent by radio are enlarged to nine times their original size by means of a new receiving apparatus designed by engineers of the Radio Corporation of America.

The possibilities of the new receiving device were illustrated when full-size advertisements of a fashion magazine were radioed successfully. Radio engineers are now working on a receiving device which will make pictures 18 times as large as the original.

The paper used in receiving the pictures was made especially for photo-radio reception. It is said to be based on a formula discovered by paper experts. A wave of heat blown on this paper will make an impression upon it.

The actual enlarging is done by a small asbestos device attached to a rubber tube, through which hot air is constantly


F. M. Delano

The short-wave transmitter used by Edouard Belin in his television experiments conducted in France. It operates on the 30-meter wavelength

being blown. A tiny opening at the end of the tube lets hot air blow on the paper, making a black mark. The pictures are produced, however, by a second tube carrying cold air, the passage of which to the paper is controlled by radio signals.

If the cold air passes in front of the current of hot air, it prevents the hot current from making a mark on the paper. Thus there is obtained the succession of black dots and lines and white spaces which, when seen together, make the picture.

THE following report is made by the navy of what is believed to have been the longest two-way communication without transmitting antennae:

"Communication was established between the Naval Research Laboratory, NKF in Washington, D. C., and Navy

The Langmuir exhaust pump used by the General Electric Company for evacuating radio tubes. Three pumps are used in the process. The last one is assisted by chemical means to remove water vapor, or a refrigerant is used to freeze it out

Research Station 4XE at Winter Park, Florida, on 13,940 kilocycles. When NKF disconnected its transmitting antenna, only a slight reduction in signal strength was noted at 4XE. A few minutes later 4XE disconnected its transmitting antenna, still continuing two-way 'break-in' contact with NKF, the radiating systems at both stations consisting only of the helices. So far as is known, this is the first two-way communication carried on over a distance of approximately 900 miles without transmitting antennae."

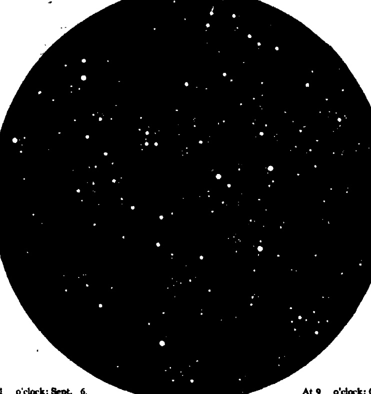
In Touch With Home

THE American yacht, *Kaimiloa*, sailed from San Francisco in October, 1924, for a wandering cruise in the South Pacific. Fred G. Roebuck, the radio operator, returned to New York recently and told how short waves brought him thousands of news dispatches, some direct from the Times Square district, 10,000 miles away from the ship's antenna. He said that, while in New Zealand waters, he talked direct with his father operating an amateur short-wave station in California. He said that the 40-meter waves carrying news from New York were "most astonishing—perfectly steady and remarkable—almost unbelievable."

The call letters of the *Kaimiloa* were KFUH and the wavelength 35 meters. The ship will leave on another cruise in the South Seas within a few months.

The Heavens in September

By PROF. HENRY NORRIS RUSSELL, Ph.D.



At 11 o'clock: Sept. 6.
At 10½ o'clock: Sept. 14.
At 10 o'clock: Sept. 21.
At 9½ o'clock: Sept. 30.
At 9 o'clock: Oct. 7.
At 8½ o'clock: Oct. 15.
At 8 o'clock: Oct. 22.

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o clock on September 6, etc.

NIGHT SKY: SEPTEMBER AND OCTOBER

The Heavens

ON our map of the sky this month, we find the great constellations of summer. Cygnus, Lyra and Aquila reign in the west, with Sagittarius low in the southwest, Ophiuchus in the west, and Hercules and Corona in the northwest. The Great Bear is low in the north, the Dragon and the Little Bear higher, and Cassiopeia and Cepheus very high. Perseus, Auriga and Taurus are in the northeast, Andromeda and Aries in the east, Pegasus high in the southeast, with Cetus below, and Aquarius, Capricornus and the Southern Fish in the south.

The Planets

Mercury is in conjunction with the sun on the 2nd, and is practically invisible until the latter part of the month, when he may be seen in the twilight, but with difficulty. Venus is also in conjunction with the sun on the 11th. She may still be seen low in the evening twilight on the 1st, and comes out in the morning sky before the month's close, but in both cases clear skies and careful watching will be required to glimpse her. In the telescope she shows a narrow crescent, of great span between the horns.

Mars is an evening star, but sets less than an hour after the sun, and is very hard to see. Jupiter is in opposition on the 22nd, and dominates the midnight sky. He is in Pisces, very close to the vernal equinox, and remote from any bright star. Saturn is in Scorpio, and is now an evening star, setting between 9 and 10 P.M. Uranus is in opposition on the 25th, and is well placed for observation. He is still quite near Jupiter in the sky; indeed, at the month's beginning he is only 40 minutes east and 70 minutes north of the brighter planet. Jupiter moves westward more rapidly, and at the end of the month is 3 degrees west and 2 degrees, 40 minutes south of Uranus. Neptune is in Leo, just past conjunction with the sun, and barely, if at all, observable. This planet, however, is of little direct interest to the observer who is not equipped with at least a small telescope, for it is exceedingly faint to the naked eye. It is now not far north of the bright star Regulus. Neptune's distance from the sun is 2,800 million miles—over thirty times as far as the earth, and it requires 165 years to make a complete revolution around the sun. It has one satellite which revolves around it in the reverse direction, but this may be glimpsed only in the largest telescopes.

The moon is in her first quarter at 6 A.M. on the 4th, full at 8 A.M. on the 11th, in her last quarter at 10 P.M. on the 17th, and new at 5 P.M. on the 25th. She is nearest the earth on the 12th, and farthest away on the 27th. She is in conjunction with Saturn on the 3rd, Jupiter and Uranus on the 12th, Neptune on the 22nd, Venus on the 23rd, Mars on the 26th, and Mercury on the 27th. At 8 P.M. on September 23rd, the sun crosses the celestial equator and "autumn commences."

Industries from Atoms

(*Continued from page 262*)

not to injure food products or the germinating power of seed, and (3) that it kills or poisons beyond recovery a very high percentage of such insects as the Indian meal moth, Mediterranean flour moth and the more resistant confused flour beetle in fumigations made on a commercial scale with dosages of chloropicrin ranging from 0.8 to 1.33 pounds per 1000 cubic feet."

Influence of Rust Film on Corrosion

"DO not clean the rust off of corroded steel," is the conclusion reached by E. L. Chappell of the Massachusetts Institute of Technology, after a careful study of the influence of the thickness of rust films on the rate of corrosion of steel. After discussing his investigations before the American Chemical Society, Mr. Chappell concludes:

"A very thick film of rust is required to decrease appreciably the corrosion rate of the copper steels, and the more easily corroded steels have a much longer life when protected by even a thin film of corrosion product. This indicates the conditions under which copper-bearing steels under water would not be superior to ordinary steel—namely, where thick films are formed. On the other hand where the rust film is removed, as by mechanical means, copper-bearing steels are likely to be more resistant. In addition, it must be concluded that the common practice of cleaning the rust accumulations from iron surfaces, such as inside water heaters and tanks, is likely to increase greatly the attack on the metal. The importance of rust-film thickness is recognized in practice, when, for example, it is pointed out that a tubular condenser will last longer if not cleaned of rust. In cases of heavy metals such as cast iron, a thick film may be allowed to build up and corrosion practically stopped.

"The effect of films of corrosion product must be carefully considered where tests of corrosion resistance are made, as neglect of this factor may lead to conditions which are not comparable to those of practice."

Re-use of Plaster of Paris Molds

THAT plaster of Paris is weakened by reburning after having once been used has long been known, and a recent investigation at the Massachusetts Institute of Technology has sought the cause of this peculiarity. The burning of gypsum to remove its water of crystallization and the hardening of the plaster thus formed by supplying water to it is well understood, but the reason why the same plaster cannot be satisfactorily regenerated by subsequent burning has not been clear. Applying X-ray methods, Dr. Marie Farnsworth has studied this problem and suggests that the addition of a small amount (¼ of 1 percent) of aluminum oxide to the plaster will improve its strength on reburning. In summarizing her results before a recent meeting of the American Chemical Society, Dr. Farnsworth said:

"It seems very likely that the deterioration of plaster of Paris on a second calcination results from the traces of uncalcined gypsum remaining. This view is

supported by the fact that the addition of small traces of set gypsum to good plaster causes it to deteriorate very markedly. Traces of many foreign substances cause a deterioration of plaster and it is just as likely that traces of many substances would improve it. It has been found that the addition of as small an amount as ¼ percent aluminum oxide will cause the tensile strength to increase about threefold, and no doubt other substances would be just as good, or even better, but a search was not made for such substances. X-ray photographs from new plaster and from re-used plaster show that the smaller the tensile strength, the larger is the particle size. The addition of aluminum oxide causes a decrease in the particle size and increases the tensile strength. This has a possible application in the re-use of plaster molds where the decrease in tensile strength on recalcination is not too great."

Reducing Hazard From Paint and Varnish Removers

THE poisonous nature of benzene, used in many paint removers, has long been recognized, and by altering the mixture compositions means have been sought to reduce the hazard to the health of users of these compounds. John Morris Weiss, a member of the Benzol Committee of the National Safety Council, recently reported to the American Chemical Society a research carried out to find a mixture which would reduce this hazard. He said in part:

"Paint and varnish removers have been developed which meet the practical requirements, the most widely used type being a mixture of benzene, acetone, and paraffin wax, in such proportions that there is always solid paraffin in the finished mixture. The proportions of ingredients in the various commercial removers of this type differ, but in the majority of formulas, the proportions of solvents vary from around 50 to 55 percent benzene and 50 to 45 percent acetone by volume, with the addition of from 3 to 5 percent by weight of wax. The wax is dissolved in the benzene and the acetone stirred in slowly, in this way precipitating the wax in a fine state of division. Both pure and 90 percent benzene are used in commercial removers.

"The proper use of wax in acetone-benzene removers results in an extraordinary reduction in the evaporation of the benzene. To obtain this reduction, acetone must be used in substantial amount so as to produce a solvent mixture in which the solubility of the wax is low; further, the percentage of wax should not be allowed to drop below a certain minimum, probably 5 percent by weight of the solvent used; and lastly, other conditions being equal, the retardation of evaporation is increased by an increase in the melting point of the wax used. With proper formulas, this retardation will result in volatilization figures from 1/2000 to 1/120 of the evaporation of the solvents themselves under the same conditions.

"It is, of course, impossible on purely laboratory tests to predicate an absolute absence of hazard when dealing with a substance of known toxicity such as benzene. It does appear, however, under reasonable conditions of ventilation in the practical use of properly proportioned acetone-benzene-wax paint and

varnish removers, that the concentration of vapors in the atmosphere will not become sufficient to constitute a hazard approaching that of other industries where the evaporation of the benzene is a necessary feature of the operation."

Treating Pea-Cannery Wastes

VARIOUS industrial wastes have presented serious problems to the engineer in disposing of them without nuisance. A method of disposing of the waste from a pea cannery has recently been developed by L. F. Warrick of the Bureau of Sanitary Engineering of the Wisconsin State Board of Health. Not only is the pollution of streams prevented but a sludge is obtained which may be profitably utilized for its fertilizer value. In describing the process used and researches involved before a recent meeting of the American Chemical Society, Mr. Warrick states the following conclusions from his studies:

"1—The oxygen demand of pea-cannery wastes can be reduced approximately 75 percent by screening and tank treatment with the application of seven and one quarter pounds of lime and three and one quarter pounds of ferrous sulfate per 1000 gallons.

"2—Prompt removal of the chemically precipitated organic matter is desirable, since a portion goes into solution when allowed to accumulate in the tank. The oxygen demand reduction averaged only 34 percent under such conditions.

"3—The sludge can be readily removed from the tank by means of a motor-driven diaphram pump, and it can be rapidly dried on sludge beds. Analysis indicates a fertilizer value estimated at $3.50 per ton.

"4—A further reduction in the residual oxygen demand of the tank effluent can be accomplished by aeration; preliminary tests indicating as much as 50 percent.

"5—Chemical treatment of pea-cannery wastes without removal of the coagulated organic solids prior to mixing with municipal sewage does not materially lighten the burden imposed by such wastes on city sewage-disposal plants.

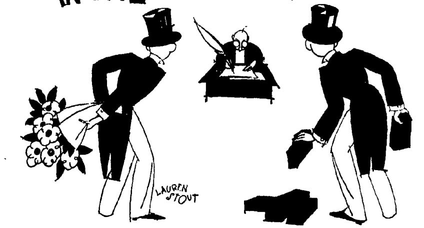
"6—The treatment will materially reduce objectionable stream pollution and prevent local nuisances often caused by untreated pea-cannery wastes."

Isopropyl Alcohol Replacing Ethyl Alcohol in Britain

IN Great Britain a prohibitive tax on ethyl or grain alcohol is leading to the wide use of isopropyl alcohol as a solvent in cheap perfumes and flavoring essences. For this purpose isopropyl alcohol is preferably blended with ethyl alcohol, thus reducing the cost of the solvent and also helping to avoid the odor of isopropyl alcohol which is stated to be heavy and persistent when used alone.

Isopropyl alcohol is made in Great Britain from acetone and this process has given it a reputation for freedom from offensive after-odor on evaporation. In the United States, isopropyl alcohol is made from petroleum and is said to be less free from odor than the British product.

IN THE EDITOR'S MAIL



Dentist Thrives on Troubles

HERE is a rather whimsical letter from a dentist who took up amateur telescope making. Not everything happened strictly according to Hoyle, but nevertheless, judging by his letter, he seems to be sticking to it like a bulldog to a root. When a man starts a job and finds everything so dead easy that his resourcefulness is never put to it to figure a way out of a hole, the work generally loses interest. Haven't you found it so?

Editor, SCIENTIFIC AMERICAN:

Yours of recent date, asking if I recall expressing interest in "make it yourself" telescopes received. I do recall it and a lot of other things besides, among them being that I ordered my copy of "Amateur Telescope Making" before they were off the press, and had to wait with what patience I could until it came; that it seemed as though my glass disks would never come; that I thought I would die of old age before I found out where to get my pitch; that I made several pitch laps for one reason or another, etc., etc., etc. . . . I am still polishing and expect to continue. My mirror has turned out to be hyperbolized to a record-breaking extent, has a turned-down edge, ingrowing toenails, small-pox and I don't know what else, but with care I expect it to pull through. One thing rather troubles me though, and that is that the habit of walking around barrels is getting to be so firmly fixed that I can never get to the office at all on ash-day without the use of almost super-human self-control.

I wish to thank you for all you have done in starting this work and opening a door which seemed to be closed to most of us.

Sincerely,
Dr. E. M. Ryder.
Brewster, New York.

Wherein We Are Told "Why"—

THE response of our readers to the question as to why they like the SCIENTIFIC AMERICAN, asked in our May issue, has been gratifying. Being only human, we like and appreciate a little praise once in awhile, especially when it is in the form of that given in the letters which we publish below. As to the letter from Mr. Wier we would like to say that there is no disgrace in being a "scientific low-brow," as he chooses to call himself. The mere fact that he is interested in science, and anxious to progress, is sufficient indication that he is hardly all that his own term would seem to indicate.

Editor, SCIENTIFIC AMERICAN:

In your May issue, you invite readers to tell why they like the latest issues of the SCIENTIFIC AMERICAN better than the older ones. While I am not an old subscriber, my subscription dating from last Christmas, when one of my boys made me a present of it, and I cannot therefore, make much of a comparison, still I can tell you why I do like the magazine.

As to the regular departments, I like those dealing with radio and aviation very much. "The Month in Medical Science" is extremely interesting, as are also the articles entitled "Inventors Who Have Achieved Commercial Success." In recent issues, the story about flint as the "steel" of prehistoric man and the one dealing with the plague of mice in California were of absorbing interest.

Many thousands of your readers may, like myself, be looking for light entertainment, hence the pages "From the Scrap-book of Science" are always a pleasure. I never pass a picture like that of the four-wheeled motorcycle, nor that of the method of changing a flat tire, without giving it my strictest attention.

You may say on reading this that "that guy is a scientific low-brow and does not know what's what in science." That is just what I am, but since this is a free country, I can be just that and offend no one.

Altogether, I must say that the SCIENTIFIC AMERICAN is entirely worth while, and that there is not a dull page in it.

Yours truly,
William S. Wier.
Atlanta, Georgia.

Editor, SCIENTIFIC AMERICAN:

In your "side-column" page, under the heading "Why?" you ask for letters from readers old and new regarding "trends" or "changes" that may have led them to buy the SCIENTIFIC AMERICAN more regularly within the past year. I hardly

know whether I may be classed among the new or the *not* new readers; perhaps more definitely as one "returned to the fold." I am a chemist, and some years ago, in the library of a du Pont laboratory, I used to look through the SCIENTIFIC AMERICAN occasionally, but for the most part I found it dry and not much to my liking.

But somehow in the last year or two I have had a revival of interest, even in chemistry, and suddenly I discoverd that the SCIENTIFIC AMERICAN brings before me a review of the very subjects I like, and brings them in a way that pleases, inspires, and sends me out revived for further work.

I have liked the photographs of the men following your "side-column" page. I do not remember that these were previously there. Then, for some reason—I cannot explain why—the style of the articles seems different. Dr. Edwin E. Slosson, Henry Fairfield Osborn, and a few others, in recent years, have had something to say about "humanizing" science, and even the physicists, chemists, and others, have brought more *rhythm* into their writings, and no doubt this has been reflected in your pages. I am of the opinion that you have added something more of expression to your paragraphs along with science, and, after all, it is poetry, art, rhythm, that holds—along with truth. Truth, of course, is science.

Then something else has happened in the world. Science becomes supreme. Mr. Millikan, with the electron, may have done much to interlink rhythm, research, and prayers, and all sides are satisfied. There have long been those who were afraid of the "material" sides of science. But now those who pray for rain more likely find their prayers answered by proper applications of definite laws—perhaps an irrigation ditch or a hose fastened to the corner of the house.

The newspapers have taken more interest in things chemical, physical, biological and the rest. This has come largely through better distribution of laboratory news—mainly I believe through *Science Service*. As people have read more of all that science is doing, they have been led to the publications of science and one of easy access is the SCIENTIFIC AMERICAN. At least this has been the effect with me and no doubt with others, too.

I, of course, subscribe to the publications of the American Chemical Society, but as for a summary even of chemistry, I find the SCIENTIFIC AMERICAN well on top. Then there are the other sciences that the chemical journals do not always touch, and the SCIENTIFIC AMERICAN helps one out of the woods.

Changes are coming rapidly. Radio alone has sent great numbers of people to the scientific journals. Then, discussions of the possibilities of changing mercury to gold—with also the very certain assurance that wood may be changed to rayon, coal tar to dyes, and coal to gasoline—have sent new devotees of science to the scientific literature.

Stories of wealth lead us on. Science has become in large measure the rainbow's end. Whatever it is we work for, we find assurance that science will help us on the way. If it is health we ask, we find promise there, and if it is friends, home,

and the lure of journeys over the earth, we also find that.

So science becomes the open door for many of our requirements. Quite naturally we turn to the publications that can bring science to us. The publication that can bring information quickly, accurately, and bring it too *recreationally*, is bound to lead the field.

Yours very truly,
G. Warren Bryan.
Salem, Massachusetts.

Editor, SCIENTIFIC AMERICAN:

This is in reply to your inquiry "Why?" in the May number. As a subscriber might look at it, it may be that the people are becoming more interested in mechanics and science, due, perhaps, to the many automobiles and motor boats that are being used, thus creating a desire to know what "makes the wheels go 'round."

Then, too, I think that you have been getting a little closer to your readers by talking to them as though you were in the same circle, or sitting about the round table, instead of standing in the rostrum and talking "over their heads," as it were. Editors should "get next" to their readers as nearly as possible, and make us feel that we are almost acquainted with them.

Louis F. Drake.
Buffalo, New York.

Another Amateur's Telescope

IN addition to the letter from a dental surgeon who has made a telescope, we reproduce in these columns a photograph of a telescope made by Mr. Earl O. Graff, of 2340 Granite Street, Philadelphia, Pennsylvania, from instructions contained in the SCIENTIFIC AMERICAN book, "Amateur Telescope Making" (two dollars, postpaid). Mr. Graff omitted to describe his instrument in detail. From the illustration we note that the mounting is of the double

Mr. Graff's telescope with its double yoke, wooden mounting, an easy type to make, and remarkably steady

yoke type. This type of mounting was also used for mounting the great 100-inch reflecting telescope of the Mt. Wilson Observatory. While it does not permit the telescope to be pointed at a small area near the celestial pole, owing to the obstruction of the axis itself (unless the mounting is made portable), this type is noted for its steadiness and simplicity. Says Mr. Graff:

(Continued on page 284)

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By Mehran K. Thomson, Professor of Philosophy and Psychology, Baker University

The motives back of human conduct; why we behave like human beings; what is the cooperation between the conscious and the subconscious; what is personality; all these topics and many others seem to be engaging the attention of a vast, growing audience who wish to study more deeply into what comprises social intelligence. Dr. Thomson analyzes these in a most interesting way, adding a distinct accomplishment to this important line of literature. D. Appleton & Co. $3.15 postpaid.

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This is a record of important investigations and applications of the practical uses of psychology affecting the personality and competence of an individual regardless of any particular activity. Part II presents the applications to the various fields of occupational activity along which line a more general interest now seems to center. A most authoritative, complete and interesting survey. D. Appleton & Co. $4.20 postpaid.

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AIRMEN AND AIRCRAFT

By Henry H. Arnold, Major, Air Service, U. S. Army

An introduction to aeronautics, of particular interest to those not initiated in the mysteries of flying, but who wish among other things to have information regarding the physical and mental qualifications for becoming air pilots, and the nature of the instruction given at flying schools. The Ronald Press. $3.65 postpaid.

AIRCRAFT YEAR BOOK, 1927

A very complete record of all that has transpired in aviation during the past year; records, engine design, equipment, dimension outlines of various types of planes, in fact practically every question of interest that might arise of accomplishment in aeronautics, could be answered by reference to this authoritative and detailed work. Aeronautical Chamber of Commerce of America. $5.25 postpaid.

ANCIENT CITIES AND MODERN TRIBES

By Thomas Gann

A detailed description of some of the most interesting and important finds of the Maya civilization, with the author's interpretation of their significance and date. Much has been added to the history of the ancient peoples of our hemisphere by this profusely illustrated work, and it satisfies one's curiosity to a large extent. Charles Scribner's Sons. $5.20 postpaid.

ACROSS ARCTIC AMERICA

By Knud Rasmussen

Born in Greenland, speaking the Eskimo language as his native tongue, the author's life course inevitably led him toward Arctic exploration. This is the record of three and one half years of life and travel from Greenland to the Bering Sea, subsisting on the country, and excavating among the ruins of a former Eskimo civilization, to study evidence of the genesis of the Eskimo. Profusely illustrated. G. P. Putnam's Sons. $5.20 postpaid.

INVENTIONS AND PATENTS

By Milton Wright

Those of our readers who have been interested in the series of articles "Successful Inventors", written by our associate, who is also the author of this book, will here find, in most acquisible presentation, the fundamentals which were the underlying basis of their success. All the steps from the initial conception through the various forms of procedure, cases, assignments, etc., are clearly set forth so that any inventor may assure to himself full safety and protection. McGraw-Hill Book Co. $2.65 postpaid.

Recent Books

HOUSE HEATING WITH FUEL OIL

By P. E. Fausler, Asso. Ed. *Heating and Ventilating*

For all who are considering installations, this book will give a practical treatment of the various phases of oil combustion and its application to domestic purposes. A detailed compendium of systems and appliances with a comprehensible explanation of the theories upon which they operate. Heating and Ventilating Magazine Co. $4.20 postpaid.

INTRODUCTION TO ORGANIC CHEMISTRY

By R. J. Williams, Asso. Prof. Chemistry, Univ. of Oregon

In the words of the author "The desire to rationalize more fully the subject of organic chemistry," made it seem "natural and desirable that organic chemistry be related to inorganic and theoretical chemistry as much as possible, in order that the whole subject be unified". So "An attempt is made to present the material in a connected and understandable story." D. Van Nostrand Co. $3.70 postpaid.

THE LOGIC OF MODERN PHYSICS

By P. W. Bridgman, Prof. Math. and Natural Philosophy, Harvard

The discovery of new facts in the domain of relativity and quantum theory calls for a new examination of the foundations of physical thought. This, the author believes indicates a necessary change of attitude toward the interpretative aspect of physics to lay an indestructible basis upon which recent physical discovery may forever rest. The Macmillan Company. $2.65 postpaid.

INTERNATIONAL YEAR BOOK

H. T. Wade, Editor

The twenty-fifth issue of this valuable review of important men and affairs of 1926. Indispensable for reference or research work and growing more valuable as time passes because of the unbiased statement of facts by which the different subjects are presented. Dodd Mead & Co. $6.95 postpaid.

ENDURANCE OF METALS UNDER REPEATED STRESS

By H. F. Moore, Research Prof. Engr. Materials, Univ. of Ill.

A summary of views and test date of the results of research since 1919, particularly with respect to airplane materials, compiled for designing, inspecting and testing engineers. A more extended and general discussion will be found in the same author's "Fatigue of Metals." Engineering Foundation. $1.15 postpaid.

FOREMANSHIP

By C. L. Gardiner

Written by a foreman who has now assumed executive functions, this exhaustive, intensely practical book is of as much interest to industrial management for its delineation of possibilities and proper functions of a foreman, as it is of vital importance to the foreman himself who would make the most of opportunity for his employer and thus doubly for himself. A. W. Shaw Co. $6.00 postpaid.

ELEMENTARY PHYSICAL CHEMISTRY

By Hugh S. Taylor, Prof. Physical Chemistry, Princeton

Presupposing a knowledge of mathematics covering the elements of differential and integral calculus, this volume is an adaptation of a large work by the same author, "A Treatise on Physical Chemistry," being however more elementary, though following the same general lines. Prof. Taylor's articles in the SCIENTIFIC AMERICAN on the Atom have been marked by a clearness and conclusiveness of style, which is characteristic. D. Van Nostrand Co. $4.00 postpaid.

THE STRUCTURE OF THE ATOM

By E. N. da C. Andrade, Prof. Physics, Artillery College, Woolwich

A critical introduction to modern atomic speculation, endorsed by highest authority, which develops the inadequacies as well as the triumphs of prevailing theories, in a form sufficiently simple to make it accessible to all serious students of the exact sciences. Harcourt Brace & Co. $10.00 postpaid.

For Sale by SCIENTIFIC AMERICAN

"I am inclosing a small photograph of my telescope. It is portable in order to permit its use to the best advantage, since I live in an industrial neighborhood and the usual drawbacks of smoke and haze are present, not to mention a large tree in the yard next door."

Bad News for Mosquitoes

HAVE you heard yet of the "mosquito fish," gambusia, a little minnow-sized chap that lunches on the larvae of mosquitoes ("wigglers") until he can hardly wiggle himself? It begins to look very much as if Dr. David Starr Jordan, fish expert and former president of Leland Stanford, Jr. University, really "started something" when he undertook to spread before the world at large, through the columns of the SCIENTIFIC AMERICAN, the news about gambusia's gluttonous appetite for mosquito larvae, for people are now introducing them in many places.

Professor Jordan writes that "those who inquire about buying gambusia would do well to write to William F. Hildebrand, United States Bureau of Fisheries at Washington. There are," he continues, "several state commissions that have stock for supplying their own states."

We asked Dr. Jordan what efforts had previously been made to introduce mosquito fish. It appears these efforts had been pretty largely confined to the scientists themselves. But the SCIENTIFIC AMERICAN bridges this gap between professional scientists and laymen and extends such things to the public. Here is Dr. Jordan's letter: (the reason he refers to the mosquito fish as "meek" is, that they are tiny and able to live in all sorts of surroundings, for example, ditch water, gutters, marshes, et cetera.)

It is said that "the meek shall inherit the earth," and I know of no fish meeker than our little gambusia, which is now spread from Macedonia around to Argentina and to the Irawaddy. Dr. Massima Sella obtained a lot of them after our experiment in Honolulu and planted them near Cadiz in southern Spain. From Cadiz a delegation was taken to Italy in 1922 and placed in four ponds near Ostia at the mouth of the Tiber. From Ostia they have now been taken to 59 other localities, mostly in Italy and some in Jugo-slavia, Macedonia, Albania and Palestine. From each of these places good reports have come. A few sceptics are doubtful of the acclimatization of the species—in these cases *gambusia holbrooki*—but they need not worry.

There is a movement in Texas to sell "bat houses" nicely fitted up to accommodate mosquito-eating bats, but no bat nor a thousand bats can keep up with the demand. Paris green in ponds is also sometimes recommended, but enough of the poison to be effective would also kill fishes and maybe cattle which drink from most ponds.

I had not given gambusia much publicity before I wrote to the SCIENTIFIC AMERICAN.

David Starr Jordan.

[Note: See SCIENTIFIC AMERICAN, May, 1926, pages 296 and 297, "Malaria and the Mosquito Fish."—The Editor.]

Commercial Property News

A Department of Facts and Notes of Interest to Patentees and Owners of Trademark Rights

CONDUCTED BY MILTON WRIGHT

The Law Protects a Secret Process

THE rights of a manufacturer to the exclusive use of a secret process are well set forth in the recent decision of the Federal Court for the Southern District of New York in passing on a motion in an action to restrain the Momsanto Chemical Works from using the Tower Manufacturing Company's secret process for manufacturing paranitraniline.

According to the evidence, the Momsanto Chemical Works secured the secret process from one Groggins, who, when in the employ of the Tower Manufacturing Company, had agreed not to disclose the process to anyone. Having worked out an improvement of the process, Groggins disclosed it to the Momsanto company, and later went into its employ.

"I cannot think that the fiduciary obligation of one bound not to disclose a secret process, or not to use such a process that has been improperly disclosed, is not violated where the process employed is used to produce an identical result in ways directly suggested by the disclosure, though slightly differing from it in detail," says the court.

"The question is one of the real scope of the secret process and the closeness of approximation of the variation. Such a matter can only be determined on the trial with all the evidence before the court.

"If it appears that either the original or the improved process as properly construed has been obtained by the defendant through disclosure of Groggins in defiance of his contract, it might make no difference that either process was a part of the prior art because there would be an estoppel as between these parties which would prevent the defendant from questioning that the process was secret and would prevent its use by the defendant.

"I can see much similarity in this respect between a secret process and a patent.

"The outstanding difference is that a patentee has a monopoly as against all the world, while the owner of a secret process has no right except against those who have contracted, expressly or by implication, not to disclose the secret, or who have obtained it by unfair means."

The Law of Equivalents

"WITHIN the patent law the substantial equivalent of a thing is the same as the thing itself; that is to say, 'if two devices do the same work, in substantially the same way, and accomplish substantially the same result, they are the same, even though they differ in name, form or shape.'

"Again, old ingredients known at the date of letters patent granted for an invention consisting of a new combination of old ingredients, if also known at that date as a proper substitute for one or more of the ingredients of the invention secured by the letters patent, are the equivalents of the corresponding ingredients of the patented combination."

The foregoing clear statement with regard to the law on substitution of equivalent devices or ingredients in a patented combination is made by Judge Reeves in the Western Missouri Federal District Court. The Johns-Manville Company, Inc., brought a suit for infringement against R. V. Aycock Company. The patent involved was for a novel gas-proof roof or cover for a storage tank for crude oil. In finding for Johns-Manville, the court says:

"Plaintiff's patent was to prevent evaporation and leakage, whereas defendant's structure was to prevent evaporation. By plaintiff's patent it is sought to confine the gas that may arise from the oil within the tank, whereas the defendant seeks to prevent its arising. Each, however, indicates a purpose to make the covering gas-tight as nearly as may be. The defendant contends that oiltank tops cannot be made entirely gas-proof and that therefore the covering processes should be with a view to prevent the formation of gas.

"The defendant has merely changed the character of sheathing adopted and used in practical operation by plaintiff. The claim does not limit the combination to the use only of metallic sheathing but is broad enough to cover any agency, ingredient or mechanism which would answer the same purpose. Defendant says it does not use the metallic sheathing. Let that be conceded, but the fact is that it employs a sheathing of a different material which serves the identical purpose as that served by plaintiff's

Patents Recently Issued

Classified Advertising

Advertisements in this section listed under proper classifications, rate 25c per word each insertion; minimum number of words per insertion 24, maximum 60. Payments must accompany each insertion.

Official copies of any patents listed in this section at 15c each; state patent number to insure receipt of desired patent copy.

Pertaining to Aeronautics

ELECTRICAL GENERATING APPARATUS FOR AIRPLANES—Capable of operation by passing air currents for the production of electricity for future use in operating the propeller independently of the gasoline motor. Patent 1634167. G. A. Wilson, Greenwood, Miss.

Pertaining to Apparel

NECKTIE AND LINING THEREFOR.—Having resilient or elastic lining which is freely stretchable laterally and is provided with means for permitting a limited longitudinal stretching. Patent 1634032. H. Leoni, c/o Super-Rubber Lining Corp., 1674 Broadway, New York, N. Y.

Chemical Processes

CHEMICAL COMPOSITION.—For whitening, filling and weighting linen or other fabric materials without causing rust stains, which comprises sodium perborate, cornstarch, sodium triphosphate, aluminum sulphate, Epsom salts and denatured alcohol. Patent 1633213. J. F. King, 506 W. 148th St., New York, N. Y.

Electrical Devices

ANTISPLASH DEVICE FOR STORAGE BATTERIES. —Which may be readily applied and removed, and will prevent splashing over of storage batteries when being rapidly charged, or being carried. Patent 1633407. A. Halikman, c/o King Tire Co., 125 W. 67th St., New York, N. Y.

ELECTRIC GASOLINE GAUGE.—For indicating the quantity of liquid in a remotely arranged tank. The device is safeguarded against explosion, for use in connection with tanks of different depths. Patent 1634165. W. E. Williams, 108 King St., Savin Hill, Dorchester, Mass.

DIAPHRAGMLESS MICROPHONE—In which a mixture of course and molecularly fine coal dust are employed as a filling material in a vibration-free receptacle to such a height that the sound waves of the lowest frequency occurring are completely absorbed. Patent 163210. E. Reisz, c/o C. Fehler & Co. S. W. 61 Belle-Alliancеplatz 17, Berlin, Germany.

Of Interest to Farmers

WEEDER.—An implement for cutting and gathering weeds in newly plowed ground, the device is provided with a means for dumping the cut weeds. Patent 1631733. M. D. Kast, Box 978, Walla Walla, Wash.

COMBINED FROST-PREVENTING AND IRRIGATING DEVICE.—Having adjustable nozzles, for supplying a fine spray to prevent trees or plants from injury by frost, or a substantial flow for irrigating purposes. Patent 1632611. R. H. Lloyd, Hastings, W. Va.

Of General Interest

BED ATTACHMENT.—By which the occupant of a bed can operate the device to raise himself to any inclined position, or a sitting position. Patent 1630453. T. B. Smith, 101 East Anaheim St., Wilmington, Calif.

reconstructed and altered metallic covering. The rule is that alterations or changes that are merely formal do not constitute any defense to a charge of infringing a patent for a combination."

The Iron Age of Trademarks

THE recent refusal of the Patent Office to register on the application of the Defender Manufacturing Company, Inc., the trademark "Iron Clad" used on sheets, pillowcases, towels and handkerchiefs made of textile fabrics, in view of the previous registration of the same notation by the Franklin Manufacturing Company for use on cotton piece goods is but one of the many reminders that we are living in what might well be termed "The Iron Age of Trademarks."

A few years ago "Irontex," "Iron Sox," "Iron Clad" and "Iron Thread" were all involved in the same action. A. V. Victorius, Inc., sought to register "Iron Sox." R. H. Macy and Company immediately entered an opposition, asserting that the purchasing public would confuse it with "Irontex," already registered by the department store. It developed, however, that the "Iron Clad" brand of Cooper, Wells and Company and the "Iron Thread" of M. and C. Mayer had both been registered before Macy's mark.

In the brief of the attorneys which led to dismissal of that action, the following statement illustrating the use of the word "iron" in trademarks was made:

"The combination of the word 'iron' with 'sox,' while it might be considered to mean iron socks, is strictly a coined and fanciful word having no meaning in the arts and conveying no meaning to the purchasing public. It cannot be held to be descriptive, as the Patent Office is practically estopped from considering it so by the registration of 'Iron Thread,' 'Iron Clad' or 'Irontex' for hosiery, all of which are equally as descriptive as applicant's mark.

"The fact that the word 'iron' is registered as an element in each of the registrations of record clearly shows that the Patent Office did not consider the word either descriptive or deceptive in connection with which it is used, and has practically adjudged each registrant entitled to the use of this word."

Here are some of the trademarks in the knit goods and textile trades showing the word "iron." They illustrate how popular it is:

"Iron Brand," "Iron Clad," "Iron Crown," "Iron King," "Iron Man," "Iron Master," "Iron Mountain," "Iron Pier," "Iron Shod," "Iron Sox," "Iron Strength," "Iron Thread," "Iron Trail," "Iron Wear," "Ironall," "Ironbound," "Ironclad," "Ironhose," "Ironman," "Ironite," "Ironknit," "Ironox," "Ironproof," "Ironrock," "Ironsides," "Irontex," "Ironwarp," "Ironwear," "Ironweave."

The "Factory-to-You" Slogan

THE Federal Trade Commission is hot on the trail of "manufacturers" who have no factories. One of them recently ordered to mend its ways is the Big G Furniture Works, operated in New York by Jacques Greenberger and Carrie Greenberger. An order has been issued barring further use of the slogan "Direct from Factory to You" and the continued use of statements to the effect that the prices at which they offer furniture for sale are factory or manufacturers' prices.

In issuing its cease and desist order the Commission says:

"By means of large signs and in their newspaper advertisements and business correspondence, according to the Commission's findings, the respondents have for more than three years represented that they were the manufacturers of the furniture in which they dealt and that their furniture was being sold to the public at manufacturer's prices, when the truth is that neither of respondents have ever had any connection with a furniture factory but bought their stock as retail dealers and sold it at retail prices.

"The Commission's findings conclude that the respondents' representations of their business and furniture deceived the purchasing public, injured respondents' competitors and were unfair methods of competition."

ACCOUNT SYSTEM.—Whereby accurate records of accounts can be kept without the necessity of the usual forms of day book and ledger. Patent 1630840. W. M. Fredenburg, 30 Cayucos Road, Paso Robles, Calif.

GUM MASSAGING AND CLEANING DEVICE.—In the nature of a pair of tongs, for gripping a roll of cotton in such manner that it may be readily applied to the gums. Patent 1631790. T. A. Buckley, 80 Carlyle Ave., Yonkers, N. Y.

CLOTHESLINE HOLDER.—Wherein it is only necessary to insert the free end of the line in a fixed support, the weight of the line increasing the clamping action. Patent 1632616. G. J. A. Molique, 2712 Delver St., Granite City, Ill.

CHECK VALVE.—Adapted to prevent flow of pressure fluid in one direction and to permit a limited volume of pressure fluid to pass in the opposite direction. Patent 1632-636. A. P. Treadwell and J. Flournoy, c/o Atlanta Chemical Co., One-O-One Building, Atlanta, Ga.

DRIVING BIT.—For race horses, wherein means are provided permitting the driver to prevent any side movement from a straight course, while guiding in the usual manner. Patent 1632589. J. S. Bristol, 214 W. 85th St., New York, N. Y.

EYEGLASS-CASE FOLDING AND PROTECTING DEVICE.—Which obviates the scratching or breaking of the lenses, retains a cleaning cloth protected from grit and provides a personal identification. Patent 1633417. D. W. Perry, 47 Mechanics St., Keene, N. H.

LIQUID-SOAP DISPENSER.—Capable of being operated to discharge predetermined quantities of liquid soap repeatedly, the parts may be readily disassembled for cleaning, but are leak-prook. Patent 1633448. W. N. Lurcott, c/o Moore Bros. Co., 154 Chambers St., New York, N. Y.

PLOTTING DEVICE.—For indicating or displaying in a diagrammatic manner certain conditions, capable of use in a law court for establishing or denying points in a trial. Patent 1633402. J. B. Furber and K. L. Rankin, National Bank Bldg., Linden, N. J.

FOUNTAIN PEN.—Having a supplemental ink reservoir contained in the usual pen cap, for use if the pen runs dry where no ink is available. Patent 1633433. H. Boyer and M. Klevins, 330 Fairmount Ave., Jersey City, N. J.

DETACHABLE-HEEL CONSTRUCTION.—Arranged to permit a dealer in boots or shoes to readily provide a leather or rubber heel, as desired by the customer. Patent 1633449. M. Mayorowitz, 1564 Longfellow Ave., Bronx, N. Y.

CAP FOR CONTAINERS.—Easily and quickly operated with the finger or thumb, providing a closure plate for use on standard collapsible tubes having standard caps. Patent 1633420. W. Schlayer, c/o Fred Schlayer, 9027—77th St., Woodhaven, L. I., N. Y.

FASTENING DEVICES.—Which have a wide range of utility but are primarily adapted for securing dust covers to the upholstery of automobiles. Patent (Reissue) 166660. D. I. Reiter, 100—5th Ave., New York, N. Y.

LIQUID APPLICATION.—A compact protected container from which iodine or other liquid may be readily dispensed from a single hole in small quantities. Patent 1633424. E. Themak, 419 E. 157th St., New York, N. Y.

MAP HOLDER.—For holding a road map in a position to be readily viewed by the driver of an automobile, the device may be attached to the windshield. Patent 1632656. A. O. Running, Dallas, Wis.

INK DISPENSER.—For printer's ink, effectively protecting the ink against evaporation when not in use, and manually operable to dispense ink in any quantity.

Do Not Give Premature Publicity

MANY an inventor has failed to obtain a patent, or if he succeeds in obtaining one, has seen it declared invalid because he unwisely gave publicity to his invention before he took steps to assert his rights to a patent monopoly. Such was the case with Louie Klima, whose design patent for barn ventilator had been assigned to the King Ventilator Company.

When the King Company sued the St. James Ventilating Company recently in the Federal Court for the Minnesota District, it developed that during the years 1913 to 1918 the King Company made and sold large numbers of ventilators of the design in suit except that they lacked a flared base. The patentee, when manager of the company, was author of the publication, widely circulated in 1913, which described the ventilator practically the same in appearance and design as that of the design in suit but lacking the flared base.

Prior to 1919 the patentee had been associated with the Queen Manufacturing Company at which time they had been making cupolas and ventilators with flared bases.

"The evidence shows that Klima, the patentee of the present suit, cannot claim any contribution except that he combined with the flared base, which was old, this superstructure above the flared base, which was old, in both configuration and ornamentation," says the court in invalidating the patent.

"The design law was intended to encourage the decorative arts. It therefore deals with appearance of the thing designed, rather than with its structure, uses or functions. But in a design patent, as in a mechanical patent, the subject matter must be novel, and must have called for an exercise of the inventive faculties.

"In order that there may be novelty, the thing must not have been known to anyone before. Mere novelty of form is sufficient."

IRONING BOARD.—Of simple, durable and practical construction, carrying a readily adjustable means for receiving and holding different sized collars, folded shirt cuffs, or other articles. Patent 1633403. F. D. Gorman, 136 E. 40th St., New York, N. Y.

PHONOGRAPH REPEATER.—Readily attachable to any phonograph of conventional form for actuating the stylus to automatically repeat the playing of a record indefinitely. Patent 1632477. H. House, 403 Pender St., W. Vancouver, B. C., Canada.

ROADWAY EMBANKMENT.—Formed from spaced longitudinal reinforced concrete walls, extending across a canyon or the like, the walls being adapted to retain earth filling which carries the roadway. Patent 1633211. E. A. Jenja, Alderpoint, Humboldt Co., Calif.

POWDER PUFF.— Having a filler which will hold the walls against caving in or becoming uneven, yet will be flexible and will eliminate bulkiness. Patent 1634175. J. J. Cosin, 133 W. 21st St., New York, N. Y.

BUILDING BLOCK.—Equipped with a metal guard which will prevent the passage of ground-nesting termites from the ground to the super-structure. Patent 1634157. R. L. Morris, c/o Smith & Wild, Honolulu, Hawaii.

BIRD HOUSE.—Adapted for use singly or in ... pecial nest-bottom which retains a large percentage of moisture from atmosphere, yet repels vermin. Patent 1634-209. O. C. Reiber, West Webster, N. Y.

POODLE-DOG DOLL.—An inflatable toy having an outer surface simulating a poodle dog or some other natural object, which may ... tand or sit. Patent 1634189. ... Hotel Broadway and

ASTRONOMICAL DEVICE.—Whereby the approximate position of the moon relative to the earth, and the earth's shadow and the moon's shadow may be determined any hour during the day. Patent 1634207. D. Phillips, Daytona Beach, Fla.

t be acci-

Hardware and Tools

SANDING ROLLER.—Which may be used for receiving sandpaper, emery paper, or buffing material, in sanding or polishing articles to shape or finish the same. Patent 1631-798. G. H. Davol, 1953¼ Argyle Ave., Hollywood, Calif.

...E.—Of durable ... greatly simplifies and facilitates the various operations incident to the forming of wire joints or splices. Patent 1633401. J. Fisher, Wabash, Ind.

WRENCH.—Capable of readily supporting itself upon a pipe after being placed in connection, and easily manipulated by one unskilled in the use of pipe wrenches. Patent 1633455. R. L. Murphy, Miera, New Mexico.

CHAIN LINK.—For attaching a chain to an adjacent chain, more particularly cross tread members of tire chains, may be readily attached without the use of tools. Patent 1633434. W. J. Bryan, 11 Bentley Ave., Jersey City, N. J.

HINGE.—Especially for use in connection with screens or storm doors, whereby they may be easily attached to or removed from the casing, without tools. Patent 1633916. F. Zoufan, 1911 So. 51st St., Cicero, Ill.

HINGE.—Which will move relatively on ball bearings, and will be more securely imbedded in the material of the door and the jamb. Patent 1634181. E. Flagg, 111 E. 40th St., New York, N. Y.

Machines and Mechanical Devices

METHOD AND APPARATUS FOR MIXING PULP. —For use in mills using a combination of wood pulp and sulphite pulp, the pulps being automatically mixed and kept in agitation until used. Patent 1631762. W. E. Rosebush, c/o Inland Empire Paper Co., Millwood, Wash.

MACHINE FOR CORING AND DERINDING FRUITS.—Especially grapefruit, conveniently operated without the necessity of handling or touching the meat of the fruit, and in a manner to preserve the appearance. Patent 1631854. J. R. Carroll, c/o A. C. Baurelie, Box 3428. Philadelphia, Pa.

BOBBIN FEEDING MECHANISM FOR LOOMS.—Adapted to automatically thre... simultaneously with the feedin... so that every movement is utilized for placing filling threads between warp threads, Patent 1631828. J. Lucas, c/o Briesen & Schrenk, 50 Church St., Hudson Terminal Bldg., New York, N. Y.

EXHAUST SYSTEM FOR PAPER-MACHINE DRIERS.—Which will efficiently remove the moist air from adjacent the driers while permitting new air to take the place of the moist air. Patent 1631833. W. E. Rosebush, c/o Inland Empire Paper Co., Millwood, Wash.

POWER-TRANSMISSION DEVICE.—For transmitting power from the fan belt of an automobile motor to a rotary polishing ... polishing the car or ... 1631500. A. S. New... Finder Mfg. Co., 131 E. 23 St., New York, N. Y.

Pertaining to Vehicles

PROTECTIVE DEVICE FOR AUTOMOBILE FUEL TANKS.—Which in addition to preventing access to the filler opening by unauthorized persons serves to brace the adjacent parts of the car. Patent 1626822. G. G. Hearn, Whighan, Ga.

RUNNER FOR AUTOMOBILE WHEELS.—So ...ucted that the driver without leavi... his ... wheels for ...w and can easily ... 1627507. J. H. Haynes, 73 Cottage St., Bangor, Me.

SIGNAL LIGHT.—Adapted for vehicles, taking the place of a tail light, stop light or parking light, also for use at street corners, building exits, etc. Patent 1626710. J. E. Wood, 1622 S. Wabash Ave., Chicago, Ill.

ANTIGLARE DEVICE—Which may be worn by drivers driving at night, preventing blinding glare and obviating the necessity of special deflecting lenses in automobile headlights. Patent 1628551. B. L. Noyes, Stonington, Me.

RADIUS-ROD CLAMP—For staying the radius rod to the front axle of a Ford automobile preventing undue stress on the usual retaining nut on the front spring perch. Patent 1627695. S. C. Ewens, Box 163, Springhill, La.

TRACTOR-WHEEL ATTACHMENT—Providing means for automatically effecting the removal of stones and dirt which collect within the channel steel rim of a tractor wheel. Patent 1630950. B. D. Landon, Canton, Pa.

LAMINATED SPRING—In which the load deflection diagrams are in the form of curved lines indicating an increase of strength in the springs as the load increases. Patent 1628371. J. H. Stott, c/o H. J. C. Forrester, Jessel Chambers, 80 Chancery Lane, London, W. C. England.

DIRECTION INDICATOR FOR AUTOMOBILES—Readily mounted in the rear window of a closed car, for a constant signal, and for indicating turns, or other action to be taken. Patent 1629425. R. Wardhaugh, P. O. Box 41, New Rochelle, N. Y.

ONE-WAY MOTOR WAY OR STREET—A concrete street with spaced smooth tracking areas, arranged for parallel lines of traffic at different speeds, and a dead or parking area. Patent 1620782. C. T. Eldridge, Mill Valley, Calif.

SIGNALING DEVICE—In the form of an arm visual by night or day, and operable in such manner that the driver will have free use of both hands. Patent 1629380. M. Goldman and R. Karaban, 277 Pennsylvania Ave., Brooklyn, N. Y.

PASSENGER AND MOVING PICTURE ADVERTISING BUS.—Have the usual appearance of a double deck bus, but constructed to present advertising, or a moving picture, to be seen at a distance. Patent 1627473.—A.

TIRE SPREADER.—Whereby the entire length of an automobile tire may be spread open for inspection or repair without removing the spreader from its operative position. Patent 1627500. V. R. Goeller, c/o Mountain Lakes Service Station, Mountain Lakes, N. J.

INNER RECEPTACLE FOR HEARSES—Which will be air-tight, water-proof, fire-proof and a perfectly sanitary receptacle within the hearse for housing the casket. Patent 1628-893. W. and A. E. Livingston, 413 W. 2nd St., Hastings, Neb.

appli-

... easily applied even though the wheels b... resting in mud. Patent 1629786. C. H... Gunthorpe, Sr., 3132 7th St., Port Arthur, Texas.

CLUTCH CONTROL FOR TRACTORS—Which permits pivotal movement of the turntable frame in respect to the coupling bar without interfering with the operation or control of the clutch. Patent 1629550. H. A. Stewart and F. L. Holt, c/o F. Holt, 309 E. Leanterdale St., Tullahoma, Tenn.

... MOLD.—W... water of condensa... prevented from backing up at the botto... of the mold, and will be drained off a... ejected. Patent 1630113. P. DeMat... c/o Munn, Anderson & Munn, 24 W. 40th St., New York, N. Y.

ACCELERATOR CUSHION—Readily adapted ... and closing the valve of a carburetor. Patent 1630199. G. W. Megnin, Myrtle Ave., Allendale, N. J.

SCARIFIER—Adapted to be quickly attached to a standard tractor, the teeth being movable toward or away from the ground, by manually controlled mechanism. Patent 1629784. G. E. Gilbert, c/o Gilbert Mfg. Co., Stillwater, Minn.

AUTOMOBILE SEMAPHORE SIGNAL—Mounted upon the top of a car, normally concealed from view but adapted to be used as an indicator for "stop" or right and left turns. Patent 1629400. C. C. Lovejoy, c/o Typographical Bureau, Court Sq., Long Island City, N. Y.

VALVE-CORE EXTRACTOR—A simple tool, small enough to get between the wheel spokes, for expeditiously extracting and replacing the cores of pneumatic tire valves. Patent 1630976. J. R. C. Smith, c/o Dominion Garage, Victoria, B. C., Canada.

GARAGE—Adapted to have the length extended, by a swingable section of the rear wall, also preventing accidents should a driver fail to instantly stop his car. Patent 1630553. W. F. Watson, 1171 Milledge Ave., Athens, Ga.

INDEX TO ADVERTISERS

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SCIENTIFIC AMERICAN

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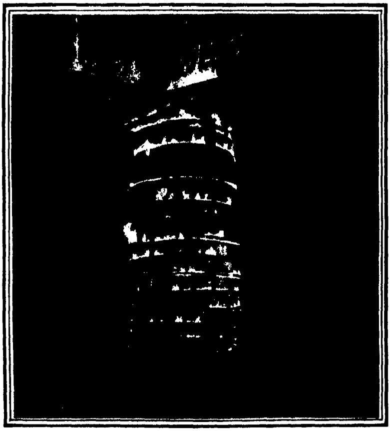

CULTURE PEARLS

BY DAVID STARR JORDAN

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Metrodyne Radio Sets are equipped for BATTERY or ELECTRIC Operation

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A single dial control, 7 tube, tuned radio frequency set. Tested and approved by Popular Science Institute of Standards, Popular Radio Laboratory, Radio News Laboratory and by America's leading Radio Engineers. Designed and built by radio experts. Only the highest quality low loss parts are used. Magnificent, two-tone walnut cabinet with beautiful, gilt metal trimmings. Very newest 1928 model, embodying all the latest refinements.

Easiest set to operate. Only one small knob tunes in all stations. The dial is electrically lighted—easy to log stations, even in the dark. The volume control regulates the reception from a faint whisper to thunderous volume, 1,000 to 3,000 miles on loud speaker! The Metrodyne Super-Seven is a beautiful and efficient receiver, and we are so sure that you will be delighted with it, that we make this liberal 30 days' free trial offer. You to be the judge.

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Mrs. Wm. Leffingwell, Westfield, N. J., writes: "The Metrodyne Radio I bought of you is a wow! This is as good as any $225 machine I have ever seen."

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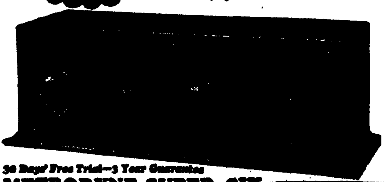
J. W. Woods, Leadville, Colo., writes: "Received the 7-tube Metrodyne in fine condition. Had it up and working the same day received. Was soon listening to Los Angeles, San Diego, Oakland and other California points; also St. Louis, Kansas City and other east and south stations—all coming in fine. Am more than pleased. Sure enjoying it."

We are one of the pioneers of radio. The success of Metrodyne sets is due to our liberal 30 days' free trial offer, which gives you the opportunity of trying before buying. Thousands of Metrodynes have been bought on our liberal free trial basis.



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Mr. Howard, of Chicago, said:—"While five Chicago broadcasting stations were on the air I tuned in seventeen out-of-town stations, including New York and San Francisco, on my loud speaker horn, very loud and clear, as though they were all in Chicago."

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Send me full particulars about Metrodyne 6 tube and 7 tube sets and your 30 days' free trial offer.

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If you are interested in AGENT'S proposition, place an "X" in the square ☐

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SCIENTIFIC AMERICAN

October 1927 *Edited by* ORSON D. MUNN Eighty-third Year

CONTENTS

OCTOBER 1927

DEPARTMENTS

Amateurs

THE average amateur scientist would like to feel that he could do something for the advancement of science. But is there very much an amateur can do that has not already been done by the professionals?

Well—we know of two jobs an amateur can do and do well. One is to make a small telescope and join the American Association of Variable Star Observers, with easy non-technical duties of great worth, nevertheless, to science; the other is to keep watch of excavations in his own locality to see that valuable fossils and ancient human evidences are not lost to science. Both jobs represent cases where numbers are needed, rather than the more highly trained work of the professional few.

In the former, charts and simple instructions are furnished and certain stars are assigned for regular observation—in fact the observer is almost given a quit-claim deed to these immense bodies. In the latter there is no association or society, but if a few thousand of our readers were to keep an eye on local excavations for cellars and engineering jobs, we believe some things of great value to science would be saved from the hungry jaws of the steam shovel.

Risky

INTERFERENCE between high-frequency radio waves that travel one way around the earth, and those that choose the other path around, is thought by a German named Quack to mutilate the signals recorded at the receiving stations. The Telefunken Company has proved that these waves do run around the earth in different directions, the time lag when transmitting being .096 of a second.

But why a single echo? Why not two? Or three? Or more? When, in fact, do these rampant radio waves stop in their tireless course?

Can it be that after a century or two of radio broadcasting these waves will begin to accumulate and get under foot, so that the poor harassed world will have to have a special squad of "radio white-wings" to gather up all of the used radio waves and burn them?

Nonsense

THE much talked of Hindu savant, Sir Jagadis Bose, has published another book about the souls of plants, and this is a thumbnail review of it. In "Plant Autographs and Their Revelations" (Macmillan, 1927) Sir Jagadis not only attempts to show that plants are endowed with feelings akin to those of man, but that metals are alive and can be killed with poison!

This popular book on botany, which has already been favorably received by uncritical new-thought healers, lovers of the occult, Yogi philosophers, dreamers, poets and pseudo-poets, gullible Sunday supplement editors and pseudo-scientists, will make a hit with all that quivering category of the emotionally unstable whose feelings joyfully run away with their rational faculties. But not with trained botanists.

The language is indeed charming and the book is interesting. What a trap for the unwary!

Science

ELEPHANTS are intelligent. Everybody likes elephants. They pile teakwood and we have heard it said that they do this without human direction. Elephants also have a long memory and take terrible revenge on aged men who as children fed them peanuts stuffed with cayenne pepper. Now we are asked to believe another, which appeared in a New York daily. Source: The *Indian News Service.*

It seems that a forest fire was rapidly spreading in India when the leader of a herd of wild elephants "smelled the fire and came to the road in order to satisfy his natural curiosity. The moment he saw the fire spreading to the forest he called his followers by loud trumpeting and within a few moments a well disciplined band of dusky four-footed firemen were busily employed, with their trunks as hose, turning 40 streams of water on the blazing tree and burning woods." Very soon, the dispatch continues, the fire was put out.

This story came out of India. But so did Sir Jagadis Bose, the Hindu scientist who would have us believe that metals are alive and that plants have souls. Altogether, India must be a wonderful place.

Cover

THE writer recently paid a visit to the plant of the Buffalo Foundry and Machine Company at Buffalo, New York, and was impressed by the preparations made for casting an ingot mold. Later a photograph was secured of the pouring and this has been translated into color by our artist. The ingot mold which is being cast weighed 125 tons. Three or four ladles are required to furnish sufficient molten metal to prevent cold shuts.

Los Angeles County "Draws" the Winning Hand

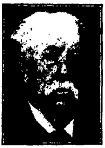
4 aces of Industry— Locate in the West's Largest Market this Year

"Drawn" to the perfect combination of factors for efficient manufacturing and distribution, Ford, Goodrich, Firestone and Sears, Roebuck & Co., either completed or commenced construction of factories in Los Angeles County during the first 7 months of 1927.

To "play" for the rich stakes of western markets, these four internationally known manufacturers are investing $20,000,000.00 in new plants here. By coming to Los Angeles County, the West's economic distribution center, they have strengthened their "hands" in the bid for Western business.

For manufacturing and distribution facts, address the Industrial Department, Chamber of Commerce, Los Angeles

Among our Contributors



PROF. DAVID STARR JORDAN

Retired president of the well known Leland Stanford Jr. University in California, which he built up from a small beginning to academic fame, Dr. Jordan is a naturalist, most of whose life work has been devoted to the scientific study of fishes. The author of many books, he now devotes his time to writing. Better than many scientists he understands the knack of popular authorship. For example, see article on page 300.

PROF. S. R. WILLIAMS

To many of us, the abstract study of physics is as dry as an Arizona summer. But there are in physics a number of concrete applications to daily life, and simple experiments which sometimes baffle, but always entertain and provide food for thought. Professor Williams of Amherst College has grouped together a number of these experiments in a two part article which begins on page 313. Don't miss it.

Dr. W. W. Coblentz

With electricity, man has turned night into day. But the firefly accomplishes as much without a thought and does it without loss of energy due to generation of heat. Will man ever succeed as well as the firefly? On page 316 Dr. Coblentz outlines this baffling problem.

Prof. E. H. Lockwood

We have been in the habit of measuring the power of a motor car by the power of the engine. But does this tell the whole story? No! Professor Lockwood of Yale has worked out a practical technique for finding out how much power a car puts *on the road.* Explained on page 330.

Horace D. Ashton

Near ancient Carthage, northern Africa, a people often simply known as "the troglodytes of the desert" dwell underground in spacious rooms carved out of dry marl. They lead a peculiar existence which is depicted on page 297, by Mr. Ashton, a fellow of the famous Royal Geographical Society. He has lived among these odd people.

Martha Miller Bliven

For years Mrs. Bliven was secretary to Carl Akeley, the noted explorer, accompanying him on his first trip to Africa. There Akeley taught her to shoot straight. Later she spent four years in French West Africa. Her account of a trip in the Belgian Congo (page 324) will arouse all the reader's suppressed instincts of wanderlust.

Looking Ahead

with the Editor

GHASTLY

Head hunting tribes in a wild district of British Burma until recently sacrificed slaves to insure a good harvest. The British Government decided to put a stop to it. A military expedition sent into the mountain fastnesses of these cruel tribes succeeded after some loss of life in freeing thousands of slaves. It makes a picturesque and absorbing story.

PHOSPHORESCENCE

Recent investigations into phosphorescent light reveal new and interesting facts about it; and what is more, they seem to point toward obtaining new insight into the structure of matter—its atomic makeup. Here is a subject for what we call a "typical SCIENTIFIC AMERICAN article." It will appear soon.

THEORY

From what peculiar primitive beginning did eyesight evolve a billion years ago? There is no direct proof, but according to one noted American eye specialist whose theory has been sent us, it evolved from the ancient ancestors of certain living amobas. Given the same circumstances again, the descendents of these amobas would again evolve sight.

NOBILITY

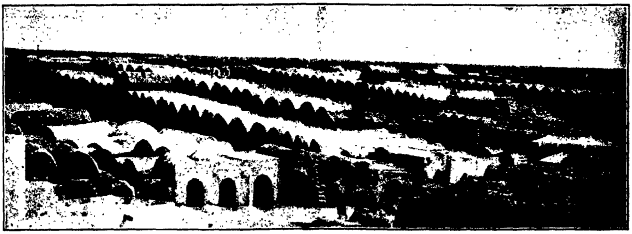
"Nobility at Work" is the misleading title of a forthcoming article about the so-called "noble" gas argon—also helium and neon. Argon is used for filling the newer electric light bulbs; helium for dirigibles, and neon for neon lamps. How these things "stack up" in commerce provides an unusually interesting—and surprising—account.

ENGINES

Have you ever thought of the human body purely as an engine? How would a modern donkey engine and hoist have fared in competition with a few hundred slaves and a corps of lashmasters in raising the pyramids of Egypt? Things like this form the text of a fascinating article by Dr. Paul R. Heyl of the U. S. Bureau of Standards. It will set you thinking.

A Troglodyte Woman and an American Oil Can!

Incongruous? Of course. But it is a thing you can see nowadays from one end of the world to the other, wherever backward or primitive people dwell. The lady is about to build a fire, and the oil can is her stove. *You* live where an empty oil can is simply an empty oil can—generally something to get rid of. *She* lives where an empty oil can is an oil can—something to be treasured. Go even to the innermost districts of China or India and you will find the same thing—the natives, in fact, are influenced in buying the oil by the fact that the useful can goes with the sale. And what can not an ingenious native do with such a can? It makes the best kind of a receptacle, and for cooking it looks as if the white man had made it for that purpose. During the temporary primitive life in the World War trenches, cut-down oil cans of the same general sort—"petrol tins" the British "Tommies" called them—served as anything from bathtub to pot and kettle, and for trench stoves as well, just as the one in the picture is serving the troglodyte housewife. She must go outdoors to do her cooking, for her subterranean home has no chimney.



THE TROGLODYTE TOWN OF MEDENINE, IN SOUTHERN TUNISIA

Here the houses are built on the level plain, in the shape of huge loaves of bread, often in two or more stories

Troglodytes of the Desert

Mysterious Tribes of Northern Africa Live in Great Circular Wells· Others Burrow into Rocky Hills, Carving Out Spacious and Comfortable Dwellings

By HORACE D. ASHTON
Fellow of the Royal Geographical Society

THREE hundred miles in a direct line south of the site of ancient Carthage, in the hills known as the Matmata Plateau, there are upwards of 30,000 people whose dwellings are merely holes in the ground. Practically all their lives are spent under ground, and when they die they are brought up and placed in shallow graves on the surface.

These people represent a race that so far antedates the Arab in North Africa that its origin is lost in antiquity. Two thousand years ago, they were, no doubt, living a pastoral life in tents in the foothills, but the armies of the Caesar, after bringing Carthage to her knees, swept south and so menaced them that they took refuge in the rocky hilltops where they dug themselves in between layers of rock and, placing bulwarks before the entrances to their caves, successfully withstood siege after siege until the Caesar's armies withdrew.

Today most of them live just as the invaders left them, for these refuge caves solved a great problem in the construction of houses where there is practically no wood. Utilizing one stratum of hard rock as a floor and the one above as a ceiling, they dug into the comparatively soft marl. Here they formed chambers whose dimensions are approximately 20 feet long, eight feet wide and with ceilings which form a perfect arch eight feet high—the whole finished off with a crude cement and whitewashed thoughout.

Some of these residences contain several chambers, always of the same dimensions, some opening from the main room, but often with independent entrances, except in the case of the harems or women's quarters. There is no furniture, the bed being, in most cases, a sort of platform or shelf in the far end of the room, about three feet above the level of the floor, but sometimes a separate platform made of wood, overlaid with white plaster. These are covered with many thick blankets woven by the women. In only one house did I see anything resembling a table, and that was in the

"What is a Troglodyte?"

Troglodyte means "to enter a hole." The troglodyte is a dug-out dweller, wherever he is. In the World War, one of the editors was frequently a troglodyte and, despite hard luck stories often told by other war veterans, he wishes he were again—minus the war! On an icy day a dug-out is warm; in midsummer it is cool. Do not pity the poor troglodytes—they get along alright.
—*The Editor.*

LIKE CATACOMBS

These curious dwellings at Medenine were clearly described by Sallust, 2000 years ago

TROGLODYTE FLAPPER

This picture was taken in one of the inhabited "wells" described in the article

HOW THE MATMATA TROGLODYTES LIVE—IN IMMENSE WELLS

In one valley, 12,000 people dwell in rooms that lead off from tunnels dug at the bottom of these broad holes

house of Sheik Mohamed Lafet of Durat. In his own room there was a small plain table upon which he kept his papers and some photographs which had been sent him by former visitors.

In all the rooms which are occupied, there are the usual divans along the side walls, upon which the people sit; for there are no chairs. In the women's quarters one finds the inevitable loom and numerous earthen bowls in which are prepared the *couss-couss* and other native dishes, and the huge jars which hold olive oil, dates, figs and other staple foods.

In front of each house is a stone-walled court yard which serves three main purposes: first, as a place in which the women of the household may remain out of doors and still have their accustomed privacy (for these people are all Moslem and the women are veiled and secluded from childhood); second, as a sort of barnyard in which sleep all the goats, donkeys and chickens, and even an occasional camel, not to mention the ever-present and always ferocious watch dog; and third, as an individual fortress in time of siege.

BEAUTY RIDES

The young and pretty women ride on camel saddles. The older, and uglier ones walk

THESE towns are usually dug into the conical, mesa-like hills of this region, which are composed of a succession of strata, sometimes to a height of 100 feet or more. The streets are arranged like terraces or huge steps, one above the other, and culminate in a *ksar* or citadel on the very summit. This served as a store house and a place of refuge in the frequent wars which prevailed until the arrival of the pacifying and enlightening French influence.

Looking out from one of these citadels across the vast intervening valleys toward the mountains opposite, the view greatly resembles that of the region of the Grand Canyon of the Colorado, for the erosion and coloring are very much the same. Especially is this similarity marked under a sunset sky, for then these red sandstone cliffs, seen through a varying blue haze, seem to recede to a greater distance and to climb to loftier heights.

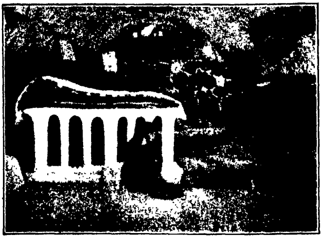
These people are known as the "climbing troglodytes." There are, in addition, several districts within a radius of a few hundred miles where others of the same race live—branches, no doubt, of the same tribes. The dwellings of these related peoples resemble those of the climbing troglodytes only in the form and dimensions of the rooms. At Ksour Medenine and in the region of Foum Tathouine and at Guerca Oulad Dabet, houses have been built on the level plain, in the shape of huge loaves of bread, arranged in numerous horseshoe groups, and sometimes to a height of five or six houses, placed one on top of another.

This grouping is said to have originated from the necessity of defense against the Tuareg marauders who used to prey regularly upon these pastoral people, robbing them of their stock, grain and, often of their women.

The houses, each comprising a single room, are called *rhoorfa* and are used

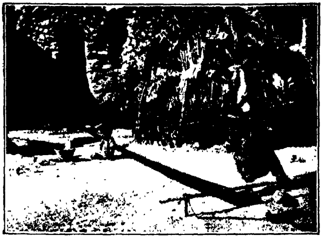
THE MATCHMAKER

At 102 she is still active. Such women usually engage in the matchmaking business



TROGLODYTE INTERIOR AT MATMATA

The bed is made of wood and covered with plaster. Note the huge jars in which are stored olive oil, barley and dates



WEAVING GOAT-HAIR TENTS BELOW GROUND

Two troglodyte women are preparing a loom to weave tents for those members of the tribe who herd flocks in the desert

principally as storehouses, although they sometimes house the old and feeble members of the tribes who are not sufficiently strong to endure the hardship of the semi-nomadic life led by some of the people; for here, fully 80 percent of the people spend nine months of the year roaming the desert with their flocks, planting and harvesting their meager crops as they go. The old folks stay behind and act as caretakers of the stores at home, awaiting the autumn home-coming. Then for three months the town is surrounded to a distance of half a mile on all sides with thousands of nomad tents.

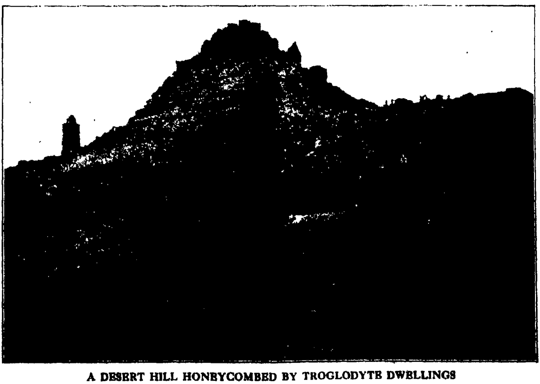
Sixty miles to the west of Medenine is the strangest of all troglodyte towns, that of Matmata. This curious and primitive community is in a class by itself. The people appear to be of the same race as those described above, but their dwellings are quite different, being huge wells which dot the whole valley as far as the eye can reach.

SURROUNDED on all sides by low mountains, on top of the loftiest of which can be seen their ancient fortresses and citadels, the valley of Matmata covers more than three square miles. It presents to the eye of the foreigner a most astonishing sight, for the whole floor of the valley is dotted with the openings of huge circular wells, about 60 or 70 feet in diameter, and about 30 feet deep.

In all the valley there are only three buildings—a school, a mosque and a market, and these have only recently been built by the French. Yet in this valley are said to dwell more than 12,000 souls without even a single tent.

These strange subterranean homes are entered through dark sloping tunnels, usually branching off into small stables on the way, and opening finally into a circular court yard, 30 feet below ground level. Around the vertical sides of this courtyard are dug the rooms of the occupants.

All of these troglodytes are most hospitable and kindly people and they extend the heartiest welcome to the visitor. Matmata and Medenine and even Foum Tathouine are readily accessible by automobile from Gabes in southern Tunisia, but the towns of the climbing troglodytes, Duirat, Chenini, Guermesa can be reached from Tathouine only by mule-back, as they lie in rugged mountains where there are only steep trails.



A DESERT HILL HONEYCOMBED BY TROGLODYTE DWELLINGS

In this locality many of the strata of rock are comparatively soft, so that the labor of excavating such terraced dwellings as these is not extremely difficult. Most of the rooms dug into this hill are invisible from outside and are poorly lighted

SOME OF MIKIMOTO'S CULTURE PEARL DIVERS, OFF TAHOKU ISLAND, JAPAN

The divers are women, young and strong, who are better workers than men, because they are supposed to be able to stay longer under water. Each diver bears water-tight goggles on her forehead

Mikimoto and the Culture Pearl

Culture Pearls Show no Difference in Color, Form or Substance from the Native Pearl. How the Japanese "Pearl King" Grows them by the Millions

By PROF. DAVID STARR JORDAN
Chancellor Emeritus, Stanford University, California

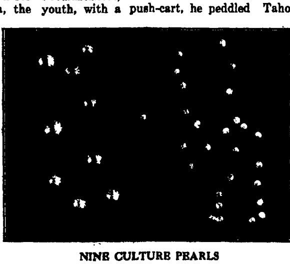
ON the southeast side of the main island of Japan lies the large peninsula of Yamato, very mountainous and picturesque, one of the early homes of the Yamato or mountain-born race, which, whatever its origin (Assyrian, possibly, or Greek—as yet unknown) now dominates Japan. On the east side of this peninsula, stretching along the large Gulf of Owari lies the province of Ise, with its two considerable seaports, Tsu and Yamada.

A few miles beyond Yamada in Ise lies the fishing village of Toba, the chief town of the very small province of Shima, which now constitutes the *ken* or prefecture of Miye. Shima is a small hilly peninsula including the Bay of Ago with its cluster of barren islands, suggesting the rocky islets of Greece, but very different as to human surroundings. The water of the inlets of southern Shima (*Shimei-Ura*) is remarkably clear. The sea has a sandstone bottom and clean tributary streams, few in number, while its southern end lies wide open to the warm wash of the *Kuroshiwo* or Black Current, the Gulf Stream of Asia which sweeps northward from Formosa and Luzon.

In the southern part of the Gulf of Owari it has long been known that a small species of pearl oyster (*Margaritifera martensi*) occurs in some abundance, and from time to time valuable pearls have been found. Thus, diving for pearls, and also for abalone, became one of the local industries of Toba, the work being mainly carried on by peasant women.

KOCHICHI MIKIMOTO, the "Pearl King," was born in Toba in 1858. His parents were in humble circumstances, and it is said that in his youth, with a push-cart, he peddled persimmons, *tofu* (soya-bean cheese,) and the like on the streets of Yamada and Toba. Mikimoto was a young man of unusual intelligence and industry and early acquired some local prominence as member of the assembly of Toba.

In 1892, at the National Exhibition in Tokyo, Mikimoto received a prize medal for an exhibit of pearls. The Japanese people set little value on pearls, (*shinju*) or on other jewels, but the foreign trade maintained a continuous demand. In 1890 he began, on Tahoku Island, in Ago Bay, to the seaward of Toba, the culture pearl industry.



NINE CULTURE PEARLS

The single pearl in center is a natural pearl; those on left are culture pearls from Tahoku Island; those at right are mother-of-pearl fragments as introduced into oysters as the basis of culture pearls. All are shown in natural size

It was known that in China, pearls had long been secured from fresh-water mussels by some form of artificial stimulus. Any object placed within the "mantle" of the mussel would cause irritation and the foreign object would be imbedded in a nacreous or pearly covering.

Professor Kakichi Mitsukuri, of the Imperial University of Tokyo, then in charge of the National Exposition, gave to Mikimoto the suggestion of experimenting on artificial stimulation which might greatly increase the number of pearls in a given area. Dr. Kamakichi Kishinouye, a grad-

uate student, now professor in the Imperial University, and Chujiro Sasaki, then a young professor interested in conchology, gave valuable help.

The ordinary pearl is a product of irritation due to the presence within the mantle of the pearl oyster of some small sea-worm or minute crustacean which has crawled into the shell. A pearl has been described as "a sarcophagus of a worm untimely dead." Any irritating object, as a grain of sand, may serve as a nucleus for a pearl.

Tahoku is a small, rocky islet in Ago Bay, about 18 miles to the southward of Toba. On and about this island Mikimoto established in 1890, the first pearl-oyster farm. Four years were devoted to experimentation, for some time with discouraging results. The earliest pearls were flattened or imperfectly spherical, a condition slowly improved and finally fully remedied in 1913.

According to a recent circular issued by Dr. Sasaki and others, the latest investigations show: "The theories of the formation of pearls have been the subject of study and discussion among scientists for centuries. Some thought that a grain of sand becomes the nucleus of a pearl, whereas others believed that internal pathological conditions produced the pearl; still others advocated the theory that the pearl is formed by the presence of parasites. All maintained their own views and there was until recently no one theory which could be accepted by many, if not by all. The latest theory, which is generally accepted, is the theory of the pearl sac formation in pearl oysters.

"THE nucleus of a pearl need not be any particular substance. It may be a grain of dirt or the larva of some parasitical worm or some other similar substance. For example, a small crustacean was found to be a nucleus. In some cases there was no nucleus at all. Therefore, from these facts we can say definitely that the nature or characteristic of a nucleus or the presence or absence of it is not

KOKICHI MIKIMOTO

The "pearl king" of Japan. It was he who developed and perfected artificial pearl culture from a very small beginning

essential for the formation of a pearl; the essential element is the pearl sac which induces the secretion of the pearl substance as connective tissue. Now, it became evident that the pearl sac is formed from the epidermis, and not from any foreign substance; that is to say, the pearl sac is formed from a portion of the epidermis cell of the mantle-parenchyma which is detached and falls on subcutaneous tissue. All natural pearls originate from the pearl sac, whether the causal stimulus for the formation of the pearl be external or internal, the pearl substance being secreted by the layer of epidermal cells of this sac. The function of these cells is precisely that of mantle-parenchyma cells."

Seventeen patents have been granted to Mikimoto for details in producing pearls and for hatching and caring for the "spat" or young pearl oysters. The latest Japanese patent (No. 33,640) describes the method as follows: "The process consists of removing from a living oyster the mantle-parenchyma which is used as a bag to envelop the nucleus of the pearl. When this nucleus, which consists of a fragment of fresh-water mussel, has been inserted in the fleshy bag, its mouth is secured with a cord, and the whole is introduced into the subcutaneous tissue of the shell-secreting epidermis of another oyster through an opening surgically made for the purpose. In the same operation the cord is withdrawn, the wound made by the lancet is disinfected, and the oyster having been returned to the sea is left to cover the nucleus with the many layers of nacre necessary to produce perfectly spherical pearls.

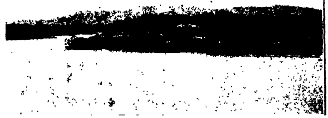
"THIS process," the Sasaki circular continues, "is extremely delicate, and unless done by selected technicians the work cannot be performed successfully. When this method was published by the Patent Office, it was believed, at least by some Japanese, that the technique of tying the mouth of the bag formed by the mantle-parenchyma would be too delicate and almost impracticable. There were certain European scientists who also held the same opinion. The actual performance of the delicate operation at the hands of expert technicians created general surprise. The pearl oysters after being so treated are left for several years in the nursery. Out of 50 oysters picked out of the bed at random, on an average 13 contain perfectly round pearls. After careful examination of these pearls, the committee came to the conclusion that they were in lustre, color and shape, and in every other way, equal to natural pearls. The attainment of this remarkable success is solely dependent on the application of science."

It was the fortune of the present writer, in November, 1922, to accept an invitation from Mikimoto, to visit Tahoku. An account of this trip was published in the *Scientific Monthly* for October, 1923. This record I condense here:

An automobile met us at Toba. My associate on this trip was Dr. Senzij Yamamoto, lecturer on genetics at the Imperial University of Kyoto, who was then helping me to complete my third collection of Japanese fishes. We left Toba on one of those perfect days

GOTOSHO, SHIMA, JAPAN

A typical pearl-fishing village in the peninsula of Shima, n center of the operations of Mikimoto. The region described b fessor Jordan lies about 300 miles southwest of the city of



TAHOKU ISLAND, AGO BAY

On this island Mikimoto began his culture pearl industry. subsequently been extended as far as J localities along the indented coast n

PEARL DIVERS AT WORK OFF GOTOSHO

Compare with the picture at top of page 300. The divers are swimming near the boat, with their tubs ready to hold the oysters recovered. Insert: Shell of a Japanese pearl oyster, half size

which come only in November and even then but seldom. After 15 miles of narrow roads through hills ablaze with maples, we reached Ago Bay. Here Mikimoto met us with what was literally a steam tub, almost as broad as long, with no deck, its interior fitted with easy chairs. It was propelled by a little engine, adequate in good weather for the few miles between Tahoku and the mainland.

Having leased this picturesque island as a base of operations, Mikimoto has secured the rights to about 50 miles of bay around it. A portion of this area is given to the spat. Small stones are scattered over the bottom, and to these the newly hatched fasten themselves by a byssus or set of threads. These are left to grow for about three years. They are then gathered, and under the mantle of each one is introduced a very small round fragment of shell (mother of pearl). These are then transferred to the south side of Tahoku into water so deep (30 to 40 feet) as to prevent all danger of freezing. The animals are "planted" about a foot apart and held for some five years more, when they are brought up by the divers, nearly every one having then a pearl of some value. The market price of these "culture pearls," (*yoshoko shinju*, "pearls for foreign trade") ranges usually from 200 dollars downward, according to their size, form and purity.

SINCE the establishment of the industry on a firm basis, and spherical pearls can be counted on, Mikimoto has extended his work from Ago Bay to eight other bays and islands along the coast to the southward, the southermost localities being Omura Bay near Nagasaki and Yayeyama Island, in the Riukiu Archipelago. Certain inlets in Hawaii have been under examination, and there are bays probably available in the peninsula of Lower California.

The total area of Mikimoto's water farms amounts to 40,380 acres. Eighty buildings are now occupied and a thousand people are employed. Three millions of oyster-spat are planted each year, and upward of a million pearls secured. Those not spherical, or which are otherwise imperfect, are destroyed, that the reputation of the culture pearl shall not be harmed. As there is no difference whatever in color, form or substance between the native pearl and the best culture pearl and as they cannot be told apart except by dissection, there is no reason why the price of the culture pearl should be lower than that of the other. There is no difference except that Mikimoto is honest in regard to his product. I may note here that the conventional "artificial pearl" commonly used in necklaces is made from fish scales and has very slight value, although well regarded as an ornament.

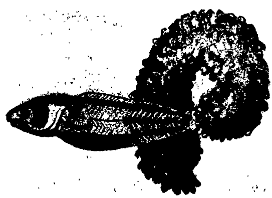
The chief enemies of the pearl industry are the "red current" (*Akashiwo*) and the octopus. The "red current" is made up of prodigious swarms of a minute flagellate infusorian that come up at times from the Philippines. When the red water invades Ago Bay, the culture cages are removed to places which the current cannot reach. Species of octopus are the most dangerous of all larger enemies, sometimes destroying the entire stock of inoculated oysters. To shut out these and other predatory creatures, Mikimoto has devised patented culture cages.

THE pearl divers (*ama*) at Tahoku form an interesting group. These are all young women from 18 to 35 years of age, vigorous and muscular. It is said that the profession has become hereditary in the province of Shima. Women are preferred to men for this work, as it is claimed that they can stay under water longer (two to three minutes). Their husbands find employment in taking care of the shells and pearls and in other duties about the island. Mikimoto's divers wear cotton suits not unlike pajamas, white cotton caps and over the eyes a large water glass for better vision. Each one as she dives from the boat has with her a floating tub in which to deposit her "clutch." In the interval between plunges the divers keep up a sharp whistling, a process which is said to give them lung strength for their work.

The salt water tends to coarsen the skin and to redden the hair, but the women seemed unusually robust and in their way not unattractive. Like all other Japanese, they are endlessly good natured, and when we left the island, after they were back in *kimono* and *obi*, they said "*Sayonara*" (goodbye) in the friendliest fashion, waving their handkerchiefs until we were out of sight. These women are in their way aristocrats among the divers.

The harvest season for pearls is in early December, but Mikimoto sent out for our edification nine of the divers, each one bringing in a pearl oyster. Opening these in his summer house on the hill, a pearl was found in each one. Two of the oysters were fried for my luncheon, and in one of these (very delicious, by the way) I found a minute natural pearl. Our visit ended, Mikimoto gave the whole pearl catch of the day as a present to Mrs. Jordan, a friendly souvenir of a delightful and instructive visit.

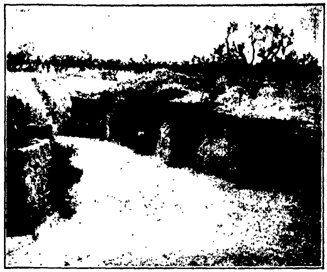
AN ODD RESIDENCE



way inside, backwards, and rest there. This figure shows one coming out. Sometimes, near Panama, these fishes live in the shell of a pearl oyster, hence the name "pearl fish"

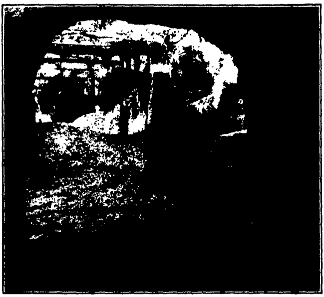
THE BUILDER OF THE CAVES

Forestierre has labored long and strenuously in building is unique underground residence and fruit farm



THE ENTRANCE FOR AUTOMOBILES

Cars can be dr are l



FREE FROM THE SUN'S GLARE

The rocks and arbor form a charming entrance to the grotto, where the temperature is found quite constant and pleasant

GROWING ORANGES UNDERGROUND

This orange tree is growing healthily underground. Many other species of fruit trees are to be found in these caves

A Modern Man-Made Cave

The rock-hewn tombs of Palestine and the catacombs of ancient Rome are visited by all tourists, but few people are aware that near Fresno, California, we have a modern counterpart. A series of 60 underground rooms have been excavated as a refuge from the summer heat and for the regulation of the ripening and drying of fruit. This series of grottos now covers an area of ten acres. It underlies an orchard of oranges, peaches and figs and vineyards. Baldassare Forestierre, the builder, is a native of Italy, who came to America years ago and obtained a ranch of 70 acres near Fresno. Here he began the building of the caves, a task to which he has devoted most of the past 20 years. He has worked steadily and lived in this unusual residence, doing only enough ranch work to provide a livelihood for himself and funds for his project. Today he has a place unique in the western world and comparable only with the famous wine cellars of France and of his native Italy. He now plans to double the size of his underground retreat, making it 120 rooms. It will include, if his dream is realized, a hotel, restaurant, garage and dance hall—a miniature dream-city beneath the surface of the ground. Some parts of the caves are already two stories beneath the surface and are accessible not only on foot, but by automobiles, which may be driven down an artistic driveway lined with orange trees in beautifully constructed niches. Forestierre, a natural horticulturist, has experimented with all kinds of trees and grape vines not only on the surface but beneath it as well, so that one of the wonders of the place is the sight of orange, lemon and grapefruit trees growing sturdily two stories beneath the level of the state highway. Light and air for these subterranean trees are admitted through holes in the domed ceilings which open upon the ground and through which sufficient sunlight streams for healthy growth. In other sections of the caverns where light without sunlight is essential, the openings are cunningly shaded by grape vines. Outside the temperature may vary from 30 degrees in mid-winter to 110 degrees in midsummer, but underneath the temperature never goes below 55 degrees in winter or above 80 degrees in summer.

OUR POINT OF VIEW

LEONARD WOOD

THE untimely death of General Leonard Wood, Governor-General of the Philippines, has removed one of the ablest and most sincerely beloved public men of America. His life during the past 30 years was that of a great soldier, an administrator of consummate ability, and an outstanding American whose record, in spite of the fierce light of publicity which always beat upon it, stands today without a blemish.

During a period which witnessed our emergence from voluntary national isolation to a commanding position among the great peoples of the world, General Wood always exercised a far-reaching, constructive influence. The briefest recapitulation of his activities establishes this fact. After serving as Colonel of the regiment of "Rough Riders" during the Spanish war, he was appointed Governor of the Province of Santiago, and then Governor-General of Cuba. Such was his executive ability, that he brought order out of chaos, organizing a stable government, and making it possible by 1903 to turn over a prosperous and peaceful country to the Cuban people. This work included the complete reorganization of fiscal, judicial, provincial and municipal affairs, and the organization of military and police forces. Soon thereafter, he was sent to the Philippine Islands as Governor of Moro Province, where he repeated his successes in Cuba.

Later, we see him appointed Chief of Staff. In this most important position he served for four years, during which he completely reorganized the General Staff. He will be gratefully remembered as the originator of our training camps. Later, at a time when the White House frowned upon even the suggestion of military preparedness, General Wood was the only high-ranking military officer who jeopardized his military future by throwing himself heart and soul into the organization and development of the famous Plattsburgh camp. It took patriotism and courage of a high order to do that, and General Wood subsequently paid the price. When the war was declared, it was the national expectation that this most able man would be given a large share in our military activities in France. Instead of this, he was retained in America, moved from pillar to post, and forbidden to accompany to France the division which he had trained.

His last great work was that of bringing order out of chaos in the Phillippine Islands—a stupendous task, which in spite of his age and somewhat broken health, he did not hesitate to undertake. He found the Phillippines hostile and left them friendly.

The writer closes this eulogy by quoting from a personal letter received from the Governor-General. "The people are happy and contented and on the whole, I think, appreciative of what we are doing. Despite all the efforts of the leaders, the lies by Philippinos against Americans, and the dissemination of false information both here and at home, I have yet to receive my first disagreeable signed or unsigned communication from any one of the twelve million people living in the islands."

NAVAL CONFERENCE DISARMED

WHEN the "naval experts" (how weary one becomes of that pet term of the propogandists) had become deadlocked at Geneva, and the prophets of calamity were predicting another "armament race," the peoples of the United States and Great Britain took hold of the situation and set it in its true light.

"We regret," they said, "that these naval gentlemen are unable to agree on the technical details, but their failure can have no serious effect upon the excellent understanding of two great nations, between whom war is simply unthinkable." Thus the public has disarmed the Conference.

Another happy result is the conviction that the discussion has cleared the air, and prepared the way for further diplomatic handling of the problem.

Briefly put, it may be said that the United States and Great Britain are agreed upon parity, but that the former favors big ships armed with big guns, and the latter prefers a large number of smaller ships armed with lighter guns. This is due to the wide difference in the naval requirements of the geographically self-contained United States and the widely scattered elements which make up the British Empire. Surely a parity can be arrived at which will satisfy both conditions. For ourselves, we must balance our navy by building additional cruisers.

New York's Airport

IN Governor's Island, situated off the tip of Manhattan, nature has provided an ideal airport for New York City. To build an airport many miles from the business heart of New York would be to rob the air service of that very time-saving which constitutes its chief, its only, advantage over train service. Of what value is a saving of three hours in the air, if two hours of the three are lost in journeys by land between flying field and city?

The commission which is making a study of the problem should place this question of time-saving far in the lead of any other considerations. If Governor's Island fulfills all other airport conditions, physical and commercial, and it does, its choice as the seat of the most important airport in the United States would seem to be inevitable.

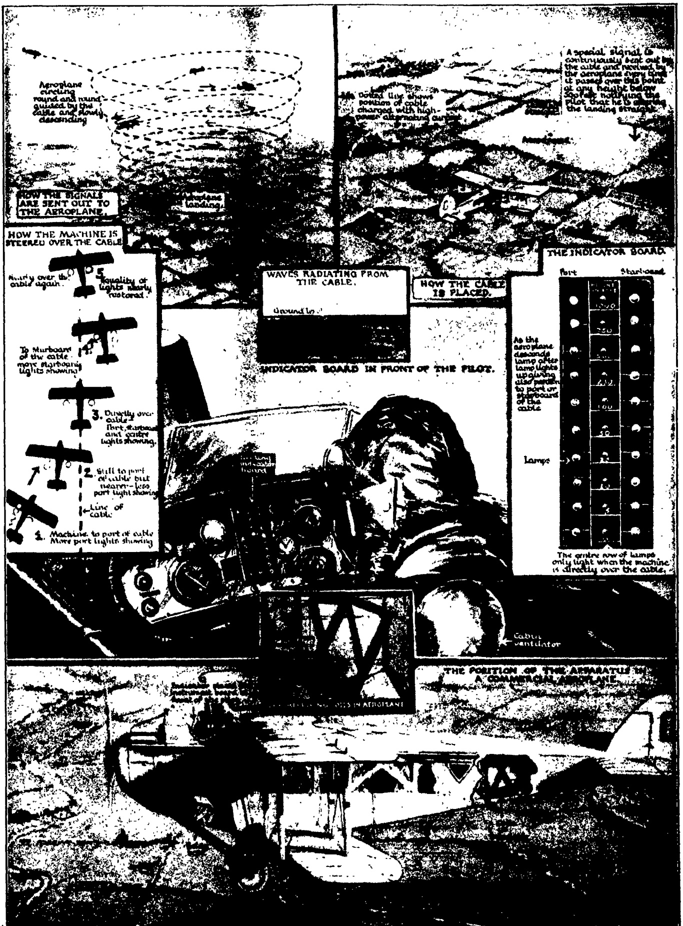
EUROPEAN AVIATION IMPRESSIONS

AFTER spending a few weeks in visiting European flying fields, the writer feels that although the network of air lines in Europe functions with extraordinary regularity and safety we in America are liable to praise unduly the superiority of commercial aviation in Europe.

If commercial aviation means a *profitable* air service, then, strictly speaking, there is no commercial aviation there. The great German *Luft-Hanza* derives from its traffic returns only about 50 percent of its running expenditures. The British Imperial Air Service receives a subsidy of 50 dollars for every passenger it carries. In strong contrast to military aeronautics, commercial aviation in France is at a very low ebb.

In the United States, the mileage flown on the regular air lines is now almost equal to the mileage of the entire European continent. Subsidies are debilitating, and the United States very wisely is helping the industry, not by subsidies but by providing lighted airways, weather reports and wise air regulation.

It is unnecessary to say that we have excellent pilots in the United States. The recent transatlantic flights prove that. Our commercial pilots have graduated mainly from Army and Navy ranks. Although our commercial flying schools are doing good work, teaching the men to solo and giving them some ground training, they wish to convert their students into a more thoroughly finished product. Therefore, the present cooperation between flying schools and the Army Air Corps Reserve will do much to improve the situation. We can learn much from the *Deutsche Verkehrsfliegerschule* in which men are trained, not only as fliers, but as engine experts, meteorologists, navigators, and are given over one hundred hours in the air before they are allowed to join the *Luft-Hanza* as assistant or apprentice pilots only.



Courtesy The Illustrated London News

NEW RADIO AID TO AIRCRAFT PILOTS

Above is illustrated a new system of directional radio which not only serves to help an airplane pilot to locate a landing field in the dark or fog, but tells him just how high he is over that field. The essential parts of the system are the buried cable and the pick-up coils on the plane.

A series of three rows of lamps show the pilot his height above the ground and also keep him posted as to his position relative to the cable. The details of the light indicators are shown and explained above, as are those of the other apparatus employed in the system

ELIZABETH BRIDGE TO STATEN ISLAND

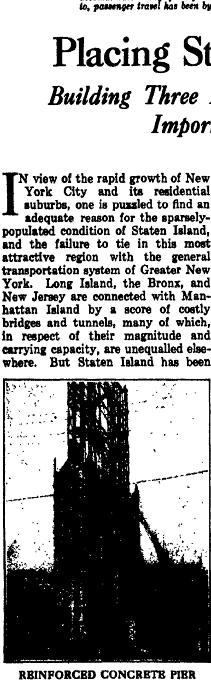
Staten Island is cut off from the mainland by navigable channels known as the Kills. These have been dredged to accommodate a large fleet of ocean-going vessels. Hitherto, passenger travel has been by ferries; but the Port Authority is now constructing three important bridges—two cantilever structures and one arch bridge. Above is the Elizabeth-Howland Hook cantilever bridge. Total length of the cantilever is 1152 feet. The center span is 672 feet

Placing Staten Island on the Map

Building Three Bridges that Will End the Isolation of an Important Section of New York City.

By J. BERNARD WALKER

IN view of the rapid growth of New York City and its residential suburbs, one is puzzled to find an adequate reason for the sparsely-populated condition of Staten Island, and the failure to tie in this most attractive region with the general transportation system of Greater New York. Long Island, the Bronx, and New Jersey are connected with Manhattan Island by a score of costly bridges and tunnels, many of which, in respect of their magnitude and carrying capacity, are unequalled elsewhere. But Staten Island has been treated as the "poor relation," and not a rapid-transit bridge or tunnel crosses its encircling waterways.



REINFORCED CONCRETE PIER

Some of the piers of the approaches are founded on wood piling and others upon reinforced-concrete spread footings

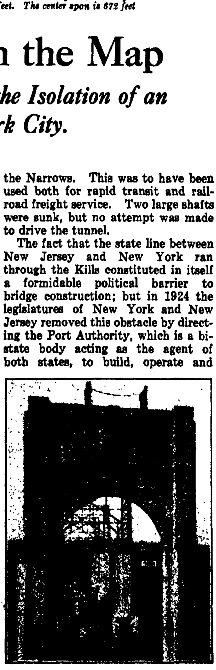
Her isolation, fortunately, is now about to be broken, thanks to the "Comprehensive Plan" of the Port Authority, under which, within a year or two, the stretches of water known as the Kill van Kull and the Arthur Kill will be spanned by two large cantilever bridges, and a few years later by an arch bridge which, with a single span of 1650 feet, will equal the length of the great bridge which is now under construction across the harbor at Sydney, Australia. These two will be the longest arch bridges in the world.

STATEN ISLAND is separated from New Jersey by the Kills, one of the most important water-ways within the Port of New York. They are together about 12 miles in length, and the width varies from a few hundred feet to nearly 2000. They have been dredged so as to accommodate deep-draft ships, and the commerce through them is today very heavy.

The agitation for a bridge has been carried on more or less vigorously for a century past, and the movement has been brought to a head largely because of the increasing use of automobiles and motor trucks.

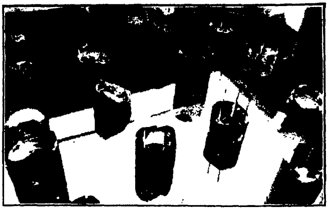
It will be remembered that a few years ago, under Mayor Hylan's administration, there was much discussion of a proposal to build a tunnel from south Brooklyn to Staten Island, on a location slightly to the north of the Narrows. This was to have been used both for rapid transit and railroad freight service. Two large shafts were sunk, but no attempt was made to drive the tunnel.

The fact that the state line between New Jersey and New York ran through the Kills constituted in itself a formidable political barrier to bridge construction; but in 1924 the legislatures of New York and New Jersey removed this obstacle by directing the Port Authority, which is a bi-state body acting as the agent of both states, to build, operate and



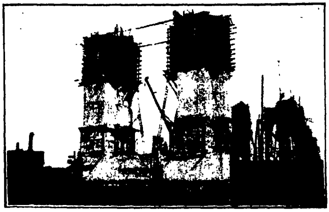
A COMPLETED PIER

Piers of the approaches to the Elizabeth Bridge, built of reinforced concrete, are simple and pleasing in appearance



OUTERBRIDGE APPROACH PIER FOUNDATIONS

The foundations for the new bridges presented no serious problems, although the substructure varied. The above view shows a set of mas-



ONE OF THE CANTILEVER PIERS

The cantilever section of the Outerbridge Cr... feet, and is made up of a center span of 750 feet

maintain two bridges, one from Perth Amboy, New Jersey, to Tottenville, Staten Island, and another from Elizabeth, New Jersey, to Howland Hook, Staten Island. Each bridge is designed for highway traffic only, and each will carry a four-lane vehicular roadway and two five-foot sidewalks on a single deck.

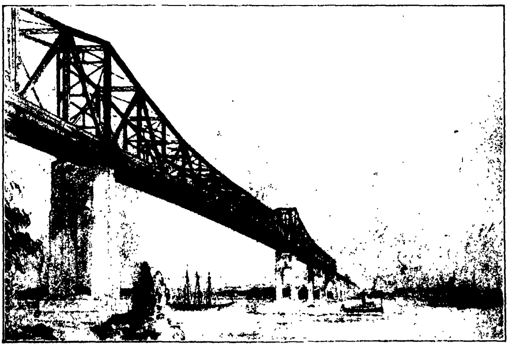
The bridge from Perth Amboy to Tottenville is to be known as the Outerbridge Crossing, in honor of the first chairman of the Port Authority. Twelve miles or so from this is to be the Elizabeth-Howland Hook bridge.

In order to attain the maximum clearance of the floor of the Outerbridge Crossing bridge above the water-way, without exceeding the maximum roadway grade of four percent, and because of topographical conditions, a bridge of great length was necessitated, the total length, including approaches, being about 10,200 feet. The bridge crosses the Arthur Kill as a high-level cantilever structure. The central span of 750 feet has a clear height above water of 135 feet. At each end of the cantilever structure is a 375-foot through-truss span.

THE main river structure is supported by arched concrete piers which, as may be seen from our illustrations, give an impression of solidity combined with dignity and simplicity of outline. The bases of the piers rest upon timber piling, all of which was driven down until the desired resistance to carry the load was secured.

The long approaches consist of lighter, arched, concrete piers similar in form to the main river piers, carrying simple, plate-girder spans. These approach piers are carried in some cases on timber piles, in others on reinforced concrete piles, and elsewhere on spread footings. The concrete piers are steel reinforced, and reinforcement is also used in the spread footings. For much of the distance, the approaches rest on firm soil, close to the surface. The total cost of the Outerbridge Crossing, it is estimated, will be approximately 10,000,000 dollars.

The Elizabeth-Howland Hook bridge will extend from McKinley Avenue in Howland Hook, Staten Island, to Edith Avenue in Elizabeth, New Jersey, The main portion of the bridge, which will be of the cantilever type, consisting of a central river span and two shore spans, will be a high level structure with an overall length of 1152 feet, and a center span over the channel of 672 feet. There will be a clear height from the



THE OUTERBRIDGE CROSSING

The Kill van Kull and Arthur Kill waterways separating Staten Island from New Jersey are from a few hundred to 2000 feet wide. Because of the heavy waterborne traffic, high-level bridges were necessary to permit passage of o... section of the Outerbridge structure is 1500 feet between the shore piers. The total length of the bridge, including the approaches, will be 10,200 feet

THE BAYONNE-STATEN ISLAND ARCH

It is only of late years that the arch has been recognized as being suitable for bridges of long span. Formerly, bridges of exceptional span, such as those across the East River, were built on the suspension principle. The first arch of great size for heavy traffic was the Hell Gate Bridge, 1000 feet long. The above bridge will be 1650 feet in length

water to the under side of the floor of 135 feet. The central span will be long enough to clear the whole width of the stream from bank to bank.

IT will be agreed, on looking at our illustration, that the bridge, with its long approaches carried on reinforced concrete piers, will present an imposing and pleasing appearance. The approaches will consist of plain girder spans carried on reinforced arched concrete piers similar in design to those employed in the approaches of the Outerbridge Crossing. Fortunately, bedrock at the crossing is close to the surface, and all the piers of the main river bridge will be carried down to this rock. The cost of the bridge is estimated at 6,584,000 dollars. The total cost of these two greatly needed and important crossings to Staten Island will be between 16,000,000 and 17,000,000 dollars, a sum which, in view of the great benefits that will be derived, would seem to be reasonable.

In considering the questions of future travel and revenue, the Port Authority made elaborate calculations as to the amount of traffic which would use the two bridges, and the amount of tolls that would be collected. These calculations were no mere guess, but were based upon a careful count of the traffic using the existing ferries from New Jersey to Staten Island, and also upon an estimate of the amount that would materially be diverted to the new structures as soon as they were available. It was estimated that traffic on the Outerbridge Crossing would be as follows: In the year 1928 there will be 1,058,600 vehicles, 3,261,000 passengers in vehicles, and 2,958,000 pedestrians. It is believed that there will be a steady increase as the years go by, and that by 1940, 3,104,400 vehicles carrying 9,562,000 passengers will use the bridge, and that the total number of pedestrians will have amounted to 6,125,000. The estimate for the Elizabeth-Howland Hook bridge for 1928 are: 897,000 vehicles, 2,361,000 passengers, and 2,074,000 pedestrians, and it is expected that by 1940 the figures under these three heads will be, respectively 2,991,000 vehicles, 7,886,000 passengers, and about 4,000,000 pedestrians.

ESTIMATES of Outerbridge bridge tolls based on a 60-cent-per-vehicle rate, showed that a return of 7.35 percent would be reached in 1940. The estimates for the Elizabeth-Howland Hook bridge at the same rate of toll are higher, starting in 1928 at 8.98 percent, and reaching 32.49 percent in 1940.

A third and far more important bridge, in point of size and capacity, is to be built across the Kills from Bayonne to Staten Island. Preliminary studies to decide what type of bridge would be most suitable to the site and the prospective traffic indicated that a single steel arch, 1650 feet in length, would not only be lower in cost than a cantilever or a suspension type, but that it would have superior esthetic merits. Sufficient borings were taken on each side of the Kill van Kull to establish the fact that good rock foundations are available.

It is only of late years that the steel arch bridge has come into its own, as a suitable type for bridges of exceptional length of span. Engineers will remember the unfeigned astonishment some 35 to 40 years ago, when Max M. Ende, a well-known engineer, showed designs for a steel arch to span the Hudson River, as being preferable to Lindenthal's designs for a suspension bridge; and it was not until nearly two decades later that the Niagara Gorge was spanned by a steel arch bridge of the then unprecedented length of 800 feet.

Today it is recognized that cantilevers may be built up to 2000-feet span, steel arches up to 3000 feet and suspension bridges up to 5000 feet, or even more, if the conditions call for it. The arch has the great advantage that it is self-contained; whereas the suspension type has to be extended on each side beyond its central span, and the enormous pull of its cables must be taken up by massive anchorages placed far in-shore.

The longest arch today is found in the crossing of the massive four-track railway at Hell Gate in the East River. This has a span of just under 1000 feet between the end pins of the arch. A bridge of the same general type is being built across Sydney harbor, Australia, which will provide for vehicles, trolley cars, and railroad transportation.

THE great arch of that bridge has a span of 1650 feet, and the same length has been adopted for the Bayonne-Staten Island bridge, which will provide, at first, a four-lane vehicle roadway, with provision for the addition of two additional lanes when it shall become necessary. The roadway will be suspended from the arch by tension members attached at the panel joints of the arch. Preliminary estimates of the traffic are: 1,560,000 vehicles and 113,500 pedestrians in 1932, and 3,380,000 vehicles and 380,000 pedestrians by the year 1950. In the first year it is estimated that the net operating income will be 6.90 percent of the cost of the bridge and that by 1947 it will have risen to 33.8 percent.

On the Trail of the Molecule—I

A Number of Most Interesting Experiments in Physics Which May be Tried by the Amateur Scientist

By S. R. WILLIAMS, Ph.D.
Professor of Physics, Amherst College

WE are going to assume that everything in the room in which you are sitting has the power to increase in size and we will let the molecules of air which we breathe expand until they are about the size of the small clay marbles with which our boys play.

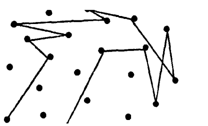


FIGURE 1

The possible path of a dancing, zig-zagging molecule of air for a short interval of time

This will mean a one hundred million fold increase in their size.

An amazing picture will be presented to us as we view these enlarged molecules. We will see them darting hither and yon, some with great and others with slow speed, but all constantly on the move. Some will strike others with a glancing blow; some will collide head on. They will rebound, ricochet and whirl through space in every conceivable direction and course. This is the eternal dance of the molecules.

On one of these perpetually moving molecules we will dab a small amount of red paint so as to follow it on its exceedingly crooked and devious trail. (Figure 1). It will make a straight path for a few moments, then glance off and start in another direction. Again it strikes head on and rebounds along its former path, only to glance and ricochet over all sorts of other paths. Eventually it gets to all parts of the room by just zigzagging here and there as shown in the diagram.

If in their career these molecules should strike the radiator heated by steam, or any other hot object, they will rebound with greater velocity and hence with more energy than that with which they struck it. In the course of time all the molecules in the room will be moving with a greater average speed than they had before turning on the steam and the average speed of the molecules becomes a measure of the temperature of the room.

THIS will be true not only of the molecules in a gas but also in a liquid and in a solid, except that in a solid there is no migration of the molecules. The higher the temperature of any body, the more vigorously do the molecules dance their eternal dance. At absolute zero their motion ceases altogether.

This constant motion of small particles due to thermal agitation can actually be seen under normal conditions by observing what is known as the "Brownian movements." Very small particles of matter such as lycopodium powder or carmine are mixed with water and observed under a high-powered microscope. The smallest particles will be seen to be going through motions quite similar to those shown in Figure 1. These motions are explained by saying that the molecules, as they dance helter-skelter, bump into larger pieces and so jostle them about in a similar fashion.

This ability to visualize and see in our mind's eye the behavior of an individual molecule has been productive of some very great advances in our knowledge of the movements of molecules *en masse*. Thus in the flow of gases and liquids it will help tremendously in understanding the phenomena observed if we focus our attention to one particular molecule and see what forces are acting upon it and how it moves under the influence of those forces.

Let either gas or water flow through pipes which have portions smaller in cross-section in one point than in others. That is, to illustrate, there is a constriction in the tube as shown at A in Figure 2. The amount of fluid which passes the cross-section at B must be the same as that at A, otherwise there would be a loss or a gain at one point or the other. If the amount passing these two cross-sections per unit of time is the same for both, then it is evident that if we observe our molecule with the red paint on it as it passes B and A we shall see that the velocity is greater at A than at B. This can occur only when the molecule has its speed increased in going from B to A, or is "accelerated," as we say in physics, which means that the pressure on the side of the molecule toward B is greater than on the side toward A. This is saying that the pressure at A is less than at B.

Wherever there is an increase in velocity of flow in a gas or a liquid due to a constriction, or the equivalent of a constriction, at that point the pressure is reduced.

This is a statement of what is known as the Principle of Bernoulli.

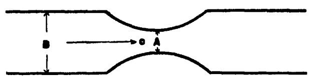


FIGURE 2

Flow in constricted tube. Moving from A to B, molecule is accelerated. Hence there will be a lower pressure at the point A than at point B

In a very extensive study of hydraulics, Daniel Bernoulli, (1700-1782), established the principle that the pressure in a fluid when at rest is different from what it is when in motion.

To come back to our picture of the molecules of air the size of marbles, if all the openings in the room are closed, the air will settle down and be at rest except for the perpetual motion of the individual molecules due to temperature. The pressure of the atmosphere, due to its weight, we measure by means of a barometer, and the reading of the barometer will be a definite value while the air is at rest. But suppose the windows are opened and the

air is allowed to blow vigorously through the room. Then the pressure as recorded by the barometer will drop. It will be found as it was found by Bernoulli that the pressure in quiet air is greater than in moving air. The first is called hydrostatic pressure and the second hydrodynamic pressure, and the distinction between these two

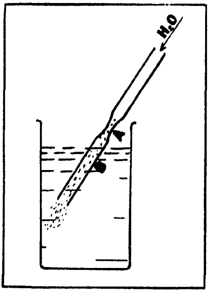


FIGURE 4

Reduced pressure at A releases air in the water in small bubbles, making it appear turbid for a short length of time

types of pressure was a very important discovery. The principle of Bernoulli may be stated in another way:

If, in the *steady* flow of a liquid or of a gas, a difference in velocity exists between any two points, it will be found that the pressure is least at the point of greatest velocity.

This very important principle discovered by Bernoulli explains some very interesting and at times startling if not paradoxical phenomena. In the case of the constricted tube shown in Figure 2, the difference in pressure between B and A may be demonstrated by the apparatus shown in Figure 3. A glass tube, three fourths of an inch to one inch in diameter,

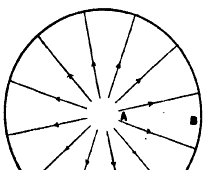
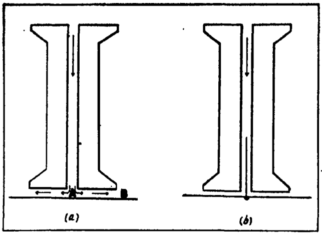


FIGURE 6

Showing the radial flow of a fluid between the disk and the spool in the disk paradox

FIGURE 5

The disk paradox, in which a disk (at bottom) actually appears to be pulled toward a jet of air shot at it through the hole in a spool. The harder one blows, the tighter the card will be pressed against the end of the spool. Try it



is drawn out to form a constriction at A. Another glass tube, one fourth of an inch in diameter, and bent in the form of a U tube, is sealed on at the points A and B and partially filled with a colored solution or with mercury. By blowing through the large tube in the direction indicated by the arrow it will be seen that the solution or mercury at UU will rise in the A side and fall in the B side, thus showing that the pressure is least at A where the velocity is greatest and that the higher pressure exists at B where the velocity is least.

The instrument shown in Figure 3 is the essential part of a Venturi meter which is used largely as a water meter, although it may be used in measuring the rate of flow of a gas. In order to use it as a meter, the difference in height of the columns in the U tube must be expressed in terms of rate of flow.

DYNAMICALLY it is the same problem whether a fluid is driven through the tube or the tube is driven through the fluid, and so the device shown in Figure 3 has been developed for use on aeroplanes to measure the velocity of the ship through the air.

One point must, however, be observed about the flow of fluids—"turbulent flow" develops very frequently, to which the principle of Bernoulli does not apply.

Under a given pressure, water contains a certain amount of air, which, when the pressure is reduced, comes out of the water in bubbles. If water under pressure is run through a tube with a constriction in it, the reduced pressure at the constriction will allow the air to come out, Figure 4, and the water will appear cloudy. This is very frequently observed when water is drawn from a faucet and a constriction is formed where the valve seats itself.

To blow against the broad side of a visiting card and make it come toward you seems paradoxical and yet when this is accomplished under proper conditions it is only obeying that fundamental law of physics about which we are talking. If the card is held near one end of a spool and air is blown through the spool from the other end, (a), Figure 5, it will be observed that the card pulls up toward the spoolor toward the blower and the harder one blows the tighter the card presses against that end of the spool.

A pin stuck through the card, (b), Figure 5, will keep the card from slipping sidewise. The air, as it emerges from the end of the spool, will be deflected by the card and flow out radially from the center, A, of the spool as shown in Figure 6. It is evident that the area of cross-section of flow increases from the center outward, making the center of the card, between the card and the spool an area of reduced pressure, compared with that on the opposite side of the

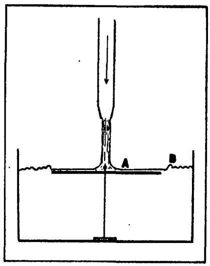


FIGURE 7

The disk paradox experiment performed with a jet of water. A piece of metal is made to float. Use any good sized dish

card. The unbalanced pressure thus produced urges the card against the end of the spool. On a large scale this procedure has been employed for holding blocks of steel in place when drop forgings are being made.

The card paradox may be demonstrated by means of a jet of water and the same spool and disk or card. A more striking way of showing this is to

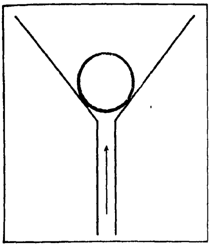


FIGURE 8

The old fashioned fireman's nozzle with a protective conical screen of water worked on this principle, which is explained in the text

place a thin disk of aluminum, five to six inches in diameter, in the bottom of a large sized cystallizing dish, Figure 7. When a well formed stream from a garden hose is directed squarely or normally at the center of the disk, the disk will rise as the dish fills. It seems to be attracted by the stream of water. When the jet of water strikes the disk it spreads out in a thin sheet over its surface and the velocity gradually comes to zero at the edge of the disk where the pressure piles up the water and forms a buoyant force on the under side of the disk, causing it to rise with the surface of the water. Is this the way in which the ancient prophet caused the ax to swim?

A variation of the spool and card experiment is to use a ping-pong ball in a funnel, Figure 8. By blowing or forcing water through from the small end there will be an increased velocity of the air or water at the points of contact between the ball and the funnel. The reduced pressure at these points allows the atmospheric pressure to force the ball into the funnel and hold it there.

Some years ago a well-known manufacturing firm in this country used as an advertising device a mechanical clown which carried a wand in each hand. Directly above the outer end of one wand a ping-pong ball was whirling and seemed to be suspended in space without visible means of support. When both arms were stretched out sidewise, the hand holding the wand, above which the ball was spinning, would be swept around in a horizontal circle until one wand came under the other. The hand having the ball in control at first would now return to its original position and the ball would remain in rotation above the other wand. The shrug of the clown's shoulders and jerk of its head indicated that there was a real question involved as to how the ball was held.

A more common demonstration of this phenomenon is the so-called "ball fountain" which is frequently seen in parks and other public resorts. A ball seems to be tumbling and whirling around in a very irregular sort of a fashion on top of a jet of water. Could one have examined the wands held by the clown he would have discovered that there was a jet of air molecules coming out of a little hole in the top of the wand and that the ball was being supported in the same manner by the air-jet as the ball in the fountain.

FIGURE 9 may represent either a jet of air or of water blown at one side of a ball. Since the ball causes the air or water to be deflected at A, in reality it forms a point of constriction to the streamlines of flow, and the pressure at A will be less than at B. This will produce an unbalanced force tending to pull the ball more and more into the stream.

If the ball goes too far and starts to fall out on the other side, the unbalanced force will change its direction by 180 degrees and again the ball will be pulled into the path of the jet. Thus if the jet is directed upward, the force of the impact of the air or water particles will hold the ball up, and if it starts to fall one way or the other, the unbalanced force will sweep it back into the jet. A friend performs this experiment by blowing into the bowl of his pipe and holding a dry pea on the jet of air which issues from the opening in the stem.

Surface tension plays an important rôle in this phenomenon, and in the other experiments other factors enter, but they will be discussed largely from the standpoint of Bernoulli's theorem.

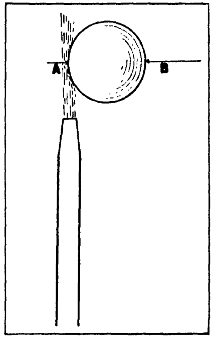


FIGURE 9

The single ball fountain. The ball is held on top of a jet of air or water, remaining there a long time, apparently without cause

Figure 10 shows the same experiment with two light hollow balls made from papier-mache and supported on two strips of thin spring steel. The balls are about four inches in diameter and separated from each other about three fourths of an inch. If one blows between them or directs the current of air from an electric fan at them, there is a tendency for both to pull toward the center of the jet and thus bump into each other. The space between the two balls is a point of constriction and therefore the pressure is less at A than at B, B.

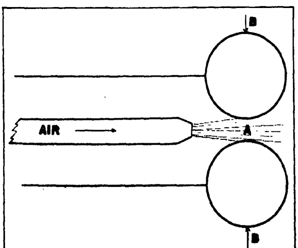


FIGURE 10

The double ball fountain. Due to reduced pressure at A the two balls are pulled together. This, according to Professor Williams, is an example of the working of the theorem of Bernoulli. The balls should be made of some light-weight material, and are about four inches in diameter. The experiment is most easily performed with the aid of an electric fan

In the next installment of the present article the writer will endeavor to show how Bernoulli's theorem may be applied to a number of commonplace occurrences and observations in life, such as the flight of a boomerang, the rotor ship of Flettner, and the failure of hot-air heating systems under certain unsuspected circumstances.

¶ Have you ever wondered how the sense of sight first came to evolve? Some scientists think it began in tiny primitive ancestral animals, with spots that became increasing sensitive to light. Next month this theory will be explained.

Four Sunless Worlds

Jupiter, Saturn, Uranus and Neptune, Once Thought to Be Hot, Are So Deeply Shrouded With Extremely Frigid Clouds That Their Surface Temperatures Remain Unknown

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mt. Wilson Observatory of the Carnegie Institution of Washington

WHILE the great planets Jupiter and Saturn are still visible in the evening skies, our attention may well be turned to them; and from the writer's standpoint such a topic is natural to choose when one is staying at an observatory where planetary observation has been pursued with especial assiduity and conspicuous success. [Editor's note: Professor Russell's manuscript reaches us this month from the famous Lowell Observatory at Flagstaff, Arizona, where so much research on the planets has been performed.]

There are probably no heavenly bodies except the moon whose telescopic appearance is better known from descriptions, drawings and photographs to the general public than Jupiter and Saturn, and they are both among the favorite objects for amateur star gazing. Yet in spite of more than three centuries of observation since Galileo's days, a great deal remains to be found out about the significance of what we see upon these planets.

Jupiter, even through a very small telescope, shows conspicuous markings—belts running parallel to the planet's equator, and darker than the rest of the surface. They differ from it in color, too, being reddish or brownish, while the regions between them are yellowish-white. A larger instrument shows a multitude of finer details—brighter and darker spots exhibiting many shades of color, which pass across the disk as the planet rotates, returning again to view in a little less than ten hours. It is possible, therefore by making a series of drawings, or better, a set of photographs to secure a map of Jupiter's whole surface in a single night.

But such a map, however accurately made, would be good for but a few weeks; for the surface details are in constant change. The minor markings may vary from day to day, and even the most prominent features change enormously from year to year. In some cases, for example, the northern hemisphere of the planet was almost free from the dark belts; in others it was free of them. Only a single prominent marking on the planet appears to be enduring—the Great Red Spot. And this, which was once brightly colored enough to deserve its name, has faded out to a pale ghost of its former self, recognizable often mainly by the "hollow" which it forms when it cuts into the side of one of the darker belts and narrows it.

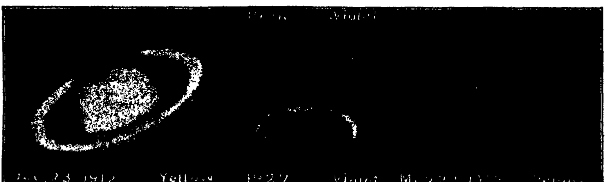
THESE markings are not only changeable, they are in rapid motion. Those on the great bright equatorial belt show a rotation period of nine hours and 50 minutes, while markings in higher latitudes take about five minutes longer for each revolution. It would appear that there is a great current flowing eastward around the equator, and carrying the markings in the zone with it, which gains five minutes in each ten hours, or a whole revolution in about 50 days. Now, it is 275,000 miles around Jupiter, hence the current must flow at the rate of nearly 250 miles per hour. The other belts are moving past one another at slower but still considerable speeds.

All these facts make it clear that the markings on Jupiter must be of atmospheric origin—clouds of some sort, and not features of a solid or even liquid surface. To be at all conspicuous on Jupiter, a cloud mass must be two or three thousand miles across. Hence the rapid changes indicate that the planet's surface is extremely turbulent.

Saturn shows somewhat similar features, but its surface is much more quiescent. The belts are less sharply defined and less numerous; and individual markings on them, by watching which the rotation can be followed, are very rare. Indeed, only two dark spots have been observed—in 1876 and in 1903. One was near the equator and gave a rotation period of 10 hours, 16 minutes; the other, 36 degrees from the equator, with a period of 10 hours, 38 minutes. The eastward current at Saturn's equator must therefore flow even faster than the one on Jupiter.

There is still more evidence that all one can see of these great planets is the upper part of their atmospheres. The mean density of both is low—1.34 times that of water in the case of Jupiter, and only 0.71 for Saturn. Moreover, from the relation between the polar flattening and the rate of rotation, it can be proved that in both planets the density is much greater near the center than at the surface. The inner cores may be as dense as rock, or even as iron, but the outer layers must be of very low density and certainly gaseous—probably for thousands of miles below the visible surface.

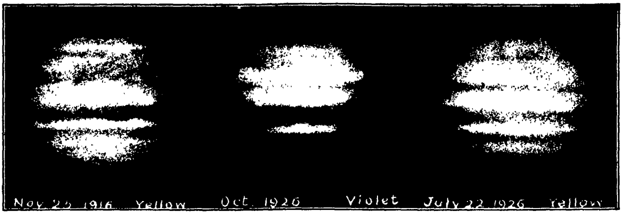
These facts are familiar enough, but their interpretation is another story. The rapid changes on Jupiter's surface



Photographed at Lowell Observatory, by Dr. E. C. Slipher

SATURN PHOTOGRAPHED AT LOWELL OBSERVATORY, IN LIGHT OF DIFFERENT COLORS

When observed with violet light, the polar regions (note center picture, bottom) and the rings show varying aspects



THREE PHOTOGRAPHS OF JUPITER, MADE BY DR. E. C. SLIPHER, AT THE LOWELL OBSERVATORY

indicate that there must be a vigorous circulation of the atmosphere, and until recently it was supposed that this must mean that the temperature was high. Indeed, some astronomers suspected that the planet, even at the surface, might be almost red hot. But the radiometric observations of Coblentz and Lampland at Flagstaff, in 1914 and later years, show conclusively that we receive practically no heat from the planet except that carried by the reflected sunlight; and from this it may be calculated that the surface temperature of Jupiter is about minus 140 degrees, Centigrade, or 220 degrees below zero on the more familiar Fahrenheit scale, and that of Saturn still lower. There seems to be no escape from this conclusion, and it follows that the upper atmospheres of these planets must be composed of the "permanent gases," oxygen, argon, neon, or helium; while the clouds cannot be composed of water, or even of ice crystals, but must be formed of some substance like carbon dioxide, which condenses at a much lower temperature.

THE inner portions of the planets are probably much hotter, and we may think of their atmospheres as being hotter deep down than at the surface, and containing layer above layer of clouds of different substances—each at the level where the temperature falls to the condensation point for its appropriate substance. Such a succession of cloudy blankets would provide a very effective barrier against the escape of heat, and prevent the warming of the surface to any serious degree by the external heat.

So far, so good: but what difficultly condensible substances known to us at room temperature as gases are they which give rise to the many kinds of markings which abound on Jupiter's surface and are present in less variety on Saturn too? We know that condensed carbon dioxide is as white as snow, and the same is true of most other solidified gases. Moreover there is something besides the familiar gases already named in the clear atmosphere which lies above the clouds, and we do not know what this constituent is. Its existence is proved by conspicuous bands in the spectrum, in the orange and red, of the light reflected from Jupiter. These bands are stronger in that from Saturn, and as Slipher has shown, are stronger still in Uranus and extraordinarily strong in Neptune. Up to the present time these absorption bands have not been matched in the laboratory, and we have no idea to what they may be due. The atmospheric temperature is so low, even on Jupiter, that the field of possibility would seem to be very limited and our lack of success surprising. Two suggestions may, however, be made in explanation.

First, it may be that these bands are absorbed with perceptible strength only when light has traversed a great thickness of the gas. For example, the strong bands of oxygen at the red end of the solar spectrum, which originate by absorption at the earth's atmosphere, can be observed in the laboratory only when transmitting light through many yards of air. And even then they are excessively faint. It requires a mile or more of air to bring them out at all strongly. But except for the gases which are present in our atmosphere, the experiment of transmitting light through a mile or two of gas has never been tried.

A SECOND possibility is that the bands may be due to some gaseous compound which is stable only at very low temperatures and is decomposed entirely at the ordinary temperature of our laboratories. This suggestion, first made by Marzel, is supported by the steady increase of the bands in passing from Jupiter to Neptune, which in all probability is colder at the surface than any other planet. Here, again, experimental evidence in the laboratory is almost lacking—except that it is known that some of the oxides of nitrogen can be protected from decomposition only by keeping them very cold. It may be that both suggestions are true, and that a great thickness of very cold gas is necessary to produce the bands.

Some similar explanation might be invoked to account for the remarkable variety of colors among the surface details of Jupiter and Saturn, which immensely exceed the range of colors exhibited by the most vivid terrestrial clouds.

All this is frankly speculative, and the reader should be on his guard against supposing that the writer means to state that these possible explanations are the correct ones. This brief discussion of them may, however, be of interest, both as indicating how many problems, still unsolved, familiar bodies like the planets present to the astronomer, and what strange apparatus he may some day be tempted to devise in searching for a solution of these problems.

ONE would hardly think, even in imagination, of astronomers desiring to build a long tube, jacketed from end to end with liquid air, to fill the tube with all the various gases with which the chemist could supply them, and then to pass light through it and see what sort of light, if any, were absorbed. But such a strange and costly equipment, and perhaps still queerer devices in which all sorts of gases were condensed into clouds to see what colors they exhibited, may one day give the clue to the nature of the visible markings on Jupiter and Saturn. It is to be hoped, however, that some simpler line of attack may prove successful, for the expensive one dreamed of here is not likely to be attempted tomorrow.

Through the courtesy of the writer's friends at Lowell Observatory it has been possible to illustrate this account with some of their beautiful photographs of Jupiter and Saturn which show more than the inexperienced observer can usually see directly, even with a good-sized telescope.

The Month In Medical Science

A Review and Commentary on Progress in the Medical and Surgical Field

By MORRIS FISHBEIN, M. D.
Editor of the Journal of the American Medical Association *and of* Hygeia

Wilshire's I-ON-A-CO

CALIFORNIA again has the privilege of providing a form of quackery beyond even the dreams of the late, but not too late, Albert Abrams. Gaylord Wilshire, whose career in socialism is not a secret, is the exploiter of the device called by him "I-On-A-Co," but aptly renamed by Dr. Arthur J. Cramp of the Bureau of Investigation of the American Medical Association as the "magic horse-collar." According to the advertising of this device, it will cure cancer, Bright's disease and paralysis, restore patients with pernicious anemia to health, relieve varicose veins, make the dumb talk and the deaf hear, and even cure a dog of St. Vitus' dance.

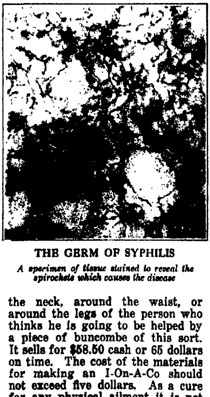
The Public Health League of the State of Washington and the Better Business Bureau of Seattle cooperated in an investigation. The investigation committee included a technician from a firm manufacturing X-ray apparatus, a business man, the secretary of the State Pharmacy Association, the secretary of the Public Health League and two physicians, also the dean of the college of engineering of the state university, the commissioner of health of Seattle, and the construction engineer from the city light department of Seattle.

The report of this committee was, in effect, as follows:

"The I-On-A-Co is simply a coil of insulated wire (about six and one-half pounds of 22 gage, worth about $3.50) about 18 inches in diameter, with a plug that permits the coil to be attached to an electric light socket. There is a smaller coil that plays no part in the alleged curative use of the I-On-A-Co but plays an all-important part in the magical features of the scheme by impressing the purchaser with the marvelous potentialities of the larger coil. The small coil is also of insulated wire (about one pound of 18 gage, worth about 60 cents), with its two free ends attached to a miniature light socket containing a small flashlight globe. When the larger coil is plugged into an electric light socket where there is an alternating current (the kind of current that is found in the great majority of city lighting systems), there is, of course, generated within the large coil a weak fluctuating magnetic field. This will cause the flashlight globe in the small coil to light up when the small coil is brought in close proximity to the large coil. This phenomenon, while elementary to a degree to those who know anything about electricity and magnetism, furnishes for the uninitiated that element of mystery which is so necessary to the successful exploitation of any alleged cure for human ailments."

As pointed out by *Hygeia*, the health magazine, published by the American Medical Association:

"The I-On-A-Co is used by placing this magnetic horse-collar over the neck, around the waist, or around the legs of the person who thinks he is going to be helped by a piece of buncombe of this sort. It sells for $58.50 cash or 65 dollars on time. The cost of the materials for making an I-On-A-Co should not exceed five dollars. As a cure for any physical ailment it is not worth five cents."



THE GERM OF SYPHILIS

A specimen of tissue stained to reveal the spirochete which causes the disease

Detecting the Organism of Syphilis

WHEN Noguchi, the famous Japanese investigator, showed that the organism that caused syphilis was present in the brains of persons suffering with "softening of the brain" and general paralysis, he made one of the most notable advances in modern medical science. Later investigators have attempted to develop methods that would reveal the presence of the germs in specimens of the tissue that were stained and put under the microscope. Recently Dr. Robert R. Dieterle of the State Psychiatric Hospital in Michigan described a method for staining this germ, which makes it visible to any observer. A specimen of brain tissue stained to reveal the germ of syphilis is here shown. By this method the spirochete which causes the disease is shown in dark brown or black in contrast with the gray color of the tissue in which it appears.

Heat Stroke

DRS. E. S. WAKEFIELD and W. W. Hall of the United States Navy Medical Department have just made public the results of a special study of heat stroke to determine the type of change that takes place which results in permanent injury. Heat stroke is one of the oldest known diseases, since descriptions of it occur in biblical legend. It has always been common on board ship because of the peculiar conditions existing below deck. The deaths of 68 persons from heat stroke during a brief hot spell in New York City is significant of the importance of this subject. There is an historical record of a hot period in Peking in July, 1743, in which 11,000 persons are said to have died.

All sorts of methods of treatment have been devised, of which, however, few are specific. More recently cold applications have been used, since the temperature tends to rise steadily. The patient is removed immediately from the heat, tight clothing is loosened and removed and the patient is given plenty of fresh air. However, following a return to consciousness there may be permanent disturbances of speech, difficulty in swallowing, headaches, dizziness, loss of appetite and even mental disturbances of great seriousness.

The observations made in the United States Navy Department indicated that heat injuries are greater in those born and reared in the northern sections of the country than in those coming from the south. Apparently it is possible to become habituated to a certain extent to heat exposure as well as to other physical conditions. The experiments also indicated that heat production in the living human being is brought about by oxidative process principally in the muscles.

In the cases studied, the animals

were submitted to considerable rise of temperature in an atmosphere with high humidity. Following heat stroke, samples of blood were obtained and studied by modern blood chemistry methods. Apparently the kidneys were greatly injured, the blood sugar increased in some cases but decreased in others, the alkali reserve was decreased greatly in every instance and the lactic acid content of the blood reached extremely high levels. The most important changes in the body are, therefore, those commonly characterized under the word "acidosis." High accumulation of acid in the body produces all of the symptoms that have been recorded. This naturally indicates specific methods of treatment which may be found to be of great service.

Discoveries by Young Men

A RECENT investigation of discoveries made in medical science brought to light the fact that many of the most important ones were the work of young men. For example, diphtheria antitoxin was first used by Von Behring when he was 31 years old. Banting discovered insulin in 1923, when he was 31 years old. Madame Curie did her work on radium in 1879 when she was 32 years old. Darwin did his work on the origin of species at 29, and Wallace contributed his share at 36. Paul Ehrlich, discoverer of salvarsan, published his earliest investigations at the age of 23. The organism of gonorrhea was discovered by Neisser when he was 24, and the organism of syphilis by Schaudinn when 34 years old.

Joy Beans

IN Cairo, Illinois, there was manufactured a preparation known as "Joy Beans." As might be guessed from the title, these pills were advertised with all of the old claims of vim, vigor and vitality in periodicals appealing principally to men. Much was said in the advertising about weak and worn out glands, about pep, fighting blood and the fountain of youth. Anybody could buy the joy beans, and they were even sold to an eighty-one year old man with the claim that they would provide him with all the attractiveness and capability of youth. An investigation of the contents of the preparation indicated it to be a mixture of half dozen or more substances supposed to be of importance in stimulating the human body but proven quite incapable of accomplishing the results claimed for them by the manufacturer. The Government recently issued a fraud order against the promoter and barred him from the use of the mails. Of course, this sort of thing can still be sold in any drug store that cares to handle it.

More Facts About Light

THE pioneer in the application of light in the treatment of disease was Finsen of the Copenhagen, Denmark, Institute. Sunlight has been most widely popularized by Rollier in Switzerland, and the ultra-violet rays largely popularized by Sir Henry Gauvain of England. Much of the most important work on the relationship of light to rickets has been accomplished by Hess and Steenbock in this country. The story is again a demonstration of the international character of advance in a branch of medical science.

Recently Dr. Edgar Mayer of the Trudeau Sanatorium group in Saranac Lake, New York, considered the fundamentals of the clinical aspects of the use of light in the treatment of disease, especially in relationship to tuberculosis. The action of the light, he points out, is largely through its effects on the skin and nerves and the blood vessels. Cholesterol, a substance found in comparatively large quantities in the skin, is activated quickly by ultra-violet rays. The substance itself may be taken from the body and made to develop power against the disease of rickets by irradiating it with ultra-violet rays. Apparently the substance that is involved is ergosterol, or an allied substance that is found in ordinary cholesterol as an impurity. The mechanisms are not definitely understood, but the effects are scientifically determinable. For example, a mother who is nursing a child may be exposed

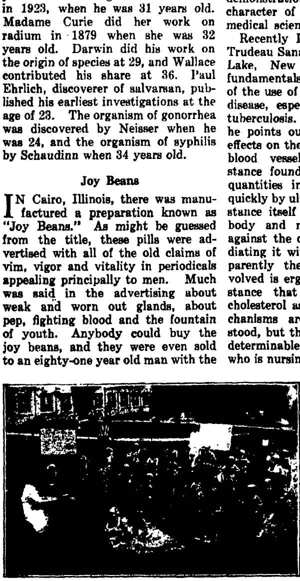
ULTRA-VIOLET TREATMENT

A patient is shown exposed to the rays emanating from a special quartz lamp

to the ultra-violet rays whereupon the substances that have the power to prevent rickets will appear in the mother's milk.

Many of the persons using light treatment believe that the only good light for the purpose is actual sunlight. It possesses the advantage of the psychic reaction which makes the patient willing to submit to prolonged periods of exposure. On the other hand, the artificial light, including either the quartz mercury-vapor arc light or the carbon arc-light can be used in any sort of weather, is easily controlled and may be measured as to actual dosage. While the dosage cannot be fixed in the same way as the dosage of a drug, it can be measured by the extent to which it produces redness or burning of the skin. An overdosage may produce injury, since apparently there are definite changes in the resistance to infection, in the setting up of serious reactions and similar processes that are of great importance.

The most visible response to the use of sunlight has been in tuberculosis of bones and joints, of the intestines and of the glands. Less visible results have been obtained in tuberculosis of the lungs, of the eyes and of the throat. While it is not urged to be unduly optimistic about this form of treatment, according to Dr. Mayer, it is important to recognize that it is one of the most important adjuvants that is available at the present time for the treatment of tuberculosis.



SUNLIGHT TREATMENT

A group of children at the outdoor school at Onondaga County Sanatorium, Syracuse, New York. They are kept out-of-doors as much as possible and the sunlight is allowed to play on their almost nude bodies. This photograph is by courtesy of Drs. Brayton and Walsh

Cold Light

How Do Fireflies Emit Light Without Emitting Heat?

By DR. W. W. COBLENTZ
Physicist, United States Bureau of Standards

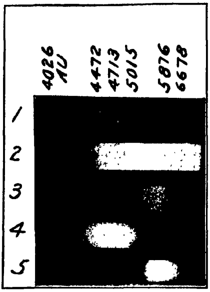
IT seems born into man to be always inquiring into the why and the wherefore of things. And certainly when it comes to the question of the artificial production of light there is a very good reason for being inquisitive.

In the days of our forefathers, the most efficient source of light was the tallow candle in which considerably less than 1 percent of the total energy radiation was emitted as light. The remaining 99 plus percent was radiated in the form of invisible "heat rays."

Even at the present day in spite of all our vaunted progress in many things, the best we can boast of in our light sources is a radiant luminous efficiency of only 5 to 10 percent. That is to say, for every dollar's worth of electrical power that we use, we obtain only about five cents worth of what we call "light." All the rest is emitted in the form of invisible ultra-violet, and especially infra-red rays, which have a great heating value. If a firefly or other luminous animal were so extravagant it would have to be provided with a special cooling system, else its body would be dried up.

"TURN to the ant and learn wisdom" may very appropriately be paraphrased to include animals and plants emitting light. For they have the secret method of emitting "cold light" consisting of a narrow band of radiant energy of short wavelengths which happen to fall into that part of the spectrum to which our eyes are sensitive. But why do they emit light that lies in this particular spectral region and not in the deep ultra-violet or infra-red? And most important of all, *how* do they do it?

One way for a physicist to attack the problem is to study the spectral range in which the light is emitted; also the shape of the spectral energy curve as compared with that of some well-known source. But the intensity of the light is so weak that it is impossible to measure it directly by means



SPECTROGRAMS

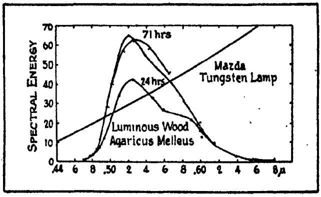
FIGURE 1—*Top, helium tube; (2) carbon filament; (3) luminous wood; (4) the crustacean Cypridina; (5) fire fly*

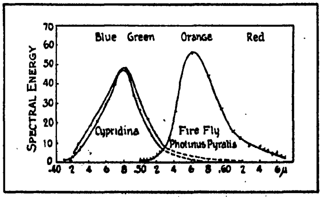
of a radiometric instrument such as, for example, a thermopile. Recourse must therefore be had to the photographic plate which is cumulative in its action and hence can be employed to advantage in this type of work.

The experimental procedure therefore consisted in holding the firefly with its luminous segments over the entrance slit of the spectrograph, and photographing the spectrum of the light emitted. The light of the firefly and the luminous crustacean (Cypridina) which lives in the ocean, is very intense and hence it requires only 30 minutes to an hour to obtain a good spectrogram. On the other hand the light emitted by the luminous wood, "fox fire," which is caused by the mycelium or vegetative system of the fungus *Agaricus melleus*, is extremely weak. It was therefore necessary to expose the photographic plate for 50 to 70 hours in order to obtain a good spectrogram of the luminous wood.

The procedure employed consisted in placing the luminous wood before the spectrometer slit and replacing it with fresh material every three hours, night and day, for three days. In the meantime the room was kept dark and the material was kept covered with a dark cloth to prevent stray light from entering the spectrometer slit.

IN Figure 1, the topmost spectrogram shows the spectrum of helium used as a comparison of wavelengths. The spectrum of the carbon glow-lamp (Figure 1) extends, of course, throughout the visible spectrum and it is used to obtain the spectral energy distribution of the other souces. The spectrum of the luminous wood extends over a wide range of the visible; whence its whitish color. The Cypridina emits a bluish light, and this is shown by the position of spectrum in the green and blue. The spectrum of the firefly lies in the orange red, as it should, for that is the color of the light emitted. By comparing the photographic densities of these spectrograms with that of the carbon glow-lamp, the spectral energy distribution is obtained, as shown in





Redrawn from Scientific Paper Number [illegible] United States Bureau of Standards

SPECTRAL ENERGY DISTRIBUTION OF FUNGUS

FIGURE 2—*This shows the intensity of the light emitted in various colors. The peak is at 0.52 microns wavelength, a micron being about one 25,000ths of an inch, and therefore it falls in the green*

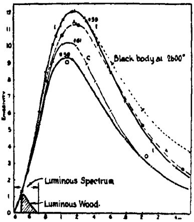
SPECTRAL ENERGY DISTRIBUTION OF OTHER ANIMALS

FIGURE 3—*Explained in the text. The visible spectrum extends from 0.39 microns wavelength (violet light) to 0.76 microns (red light). A micron equals 10,000 Angstrom units (AU, Figure 1, top)*

Figures 2 and 3, at bottom of page 316.

The spectral energy distribution of the luminescent fungus *Agaricus melleus* (Figure 2) is unsymmetrical, extending from 0.48 to 0.67 microns with an intense emission maximum at 0.52 microns, and probably a weak maximum at 0.58 microns. As shown in Figure 4 the spectral energy curve is entirely lacking in infra-red, as compared with one of our most useful sources of light.

The spectral energy distribution of the luminescent crustacean, Cypridina, (Figure 3) is symmetrical, extending



A COMPARISON

FIGURE 4—*When man produces light with tungsten filaments (upper curves) most of the energy is expended in heat or infra-red waves (beyond 0.76 microns). But note that none whatever of its energy is thus wasted in making heat by luminous wood*

from 0.41 to 0.62 microns, with a maximum at 0.48 microns in the blue-green. The spectral energy curve of the light emitted by the firefly, *Photinus pyralis*, (Figure 3) is unsymmetrical, extending from 0.50 to 0.68 microns, with a maximum in the region of 0.565 microns, verifying previous observations.

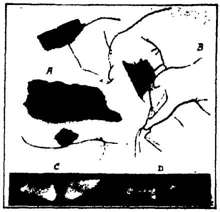
The light emission of decaying wood presents some interesting problems. At A in Figure 5 is shown a piece of wood, the bright edge of which emits light, caused by the mycelium of the fungus, *Agaricus melleus*. At B is the brown tubular mycelium growing out of the wood. The tip B where the active metabolism [Chemical processes taking place in the living cell —Editor] is in progress, is greenish yellow in color, and it emits light. C and D are photographs of a piece of wood made by the light emitted by the fungus, by placing the wood in contact with the photographic plate. The central dark region shows the path of the steel chisel used in splitting the wood.

This picture shows, as found by others, that the most intense light emission is obtained from the broken and torn mycelium on the surfaces that had not been touched in splitting the wood. An interesting observation is that the brightest glow occurs on that portion of the surface close to the part compressed by the chisel. Whether this is owing to the greater number of mycelia compressed into this space or to stimulation remains undetermined.

For more than three centuries it has been known that this kind of light production requires oxygen and that it is not a heat-producing combustion of the wood. The mycelium lives for years and the light of a luminous form of fungus seems to continue while active metabolism is in progress. One sample has been kept since September, 1925, and it is still active.

Although the extent of the spectrum of a number of luminous organisms has been photographed, but little information is at hand concerning the distribution of the energy in the spectrum of the light emitted. The present investigation being conducted at the United States Bureau of Standards is a small contribution to this subject. Just how it will fit in with other work cannot be foretold. Thus it was with my research 15 years ago when it was shown that the light emitted by various species of fireflies differs greatly in spectral energy distribution.

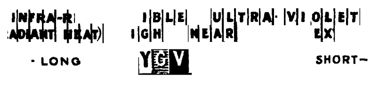
IN an unforeseen and unexpected manner, this information proved useful in showing which is the light-producing and which is the light-giving substance (luciferin and luciferase) that is obtainable from the firefly. By dialysis, the process of separating the soluble crystalloid substances in a mixture from the colloidal ones, Prof. E. Newton Harvey of Princeton, was able to show that the material obtained from the luminous organs of fireflies can be separated into two constituents which are essential in light production. These two constituents are (1) a heat-resistant, dialyzable substance called luciferin which takes up oxygen and oxidizes with light production in the presence of (2) a heat-sensitive, non-dialyzable, enzyme-like [Enzymes are catalyzers or promotors of chemical reactions in living cells—Editor] substance called luciferase. The latter appears to be an organic catalyzer which accelerates the oxidation of the luciferin, the intensity of the luminescence being dependent upon the reaction velocity or rate of oxidation. By mixing the luciferin of one species of firefly with the luciferase of another species, Professor Harvey was able to show that the light produced is characteristic of the animal supplying the luciferase.



TAKES ITS OWN PHOTOGRAPH

FIGURE 5—above, *Luminous wood; below, it photographs itself, as explained in the text*

In conclusion as in the beginning of this paper we ask the question *"How do they do it?"* It is not a question of selective transmission through the outer skin or coat, whether animal or vegetable matter. As far as we can determine, they produce these rays in the visible spectrum, and there only. On the other hand, when we human beings want visible rays we must produce practically the whole spectrum—ultra-violet, visible, infra-red. The overall efficiency of bio-luminescence is probably not much higher than that of man-made light, as shown by Harvey. Nevertheless, to be able to control the emission of radiation to the particular part of the spectrum desired, especially to visible spectrum rays, is a problem that remains to be solved.



THE FEW RADIATIONS OUR EYES PERCEIVE

This is a small part of the great electromagnetic spectrum which extends all the way from wireless waves to cosmic rays. It includes only the comparatively narrow band of wavelengths which is perceptible to our sense of sight, with part of its infra-red neighbor on the left and ultra-violet neighbor on the right. The letters are for the colors of the visible spectrum. For convenience, the physicist sub-divides arbitrarily the ultra-violet into near, far and extreme

◄ **HOT!**

The hottest part of the laboratory is in the furnace illustrated, where the most refractory of all metals can be melted by means of electricity

COLD! ►

In contrast with the furnace, is the machinery for the manufacture of liquid air. In the illustration, a man is pouring some of the liquid

Dr. W. R. WHITNEY

He is the director of the laboratories in which these photographs were taken

Dr. IRVING LANGMUIR

An assistant laboratory director, he has contributed much of value to science

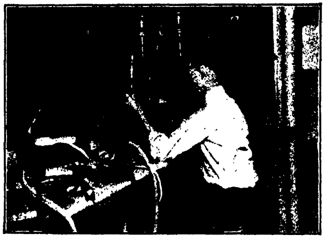
Dr. W. D. COOLIDGE

Also an assistant director, his most famous work has been with cathode rays

All photographs courtesy General Electric Company

Dr. LANGMUIR'S EXPERIMENTAL TABLE

Many valuable contributions to science, including the well-known ductile welding process, have been worked out at this bench

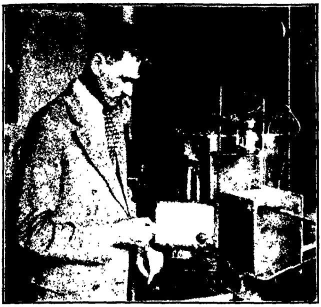


THE GLASS-BLOWING LABORATORY

Many pieces of intricate glass apparatus are required by the laboratories. A corps of expert glass-blowers furnish them all

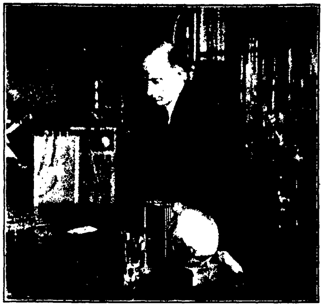
In the Workshop of the Scientists

THAT scientific experimental and research work is on a sound and result-bringing basis is proved by the series of photographs taken in the laboratories of the General Electric Company and reproduced above. Here we also find portraits of three of the men who are daily applying their vast knowledge of the various branches of science to the solution of problems which will eventually accrue to the benefit of mankind in some form. That this form may be far different from that which was first in mind when the experimental work was started has often been the fact, but nevertheless, the results are practically always well worth while. In these laboratories have been developed such commercial processes as the electric arc for welding, the manufacture of ductile tungsten, the atomic-hydrogen welding method, and the construction of X-ray tubes of all sizes and powers. Coincident with these commercial developments have been the work on such devices as the well-known Coolidge cathode-ray tube. First a scientific curiosity, the rays generated by these tubes are finding uses now which were heretofore unthought of. Then there



A SINGLE METAL CRYSTAL ▲

The scientist holds a single crystal of zinc produced in the furnace shown above

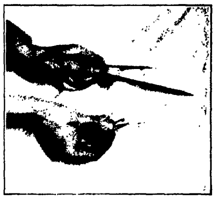


▲ MEASURING DAYLIGHT

The photoelectric cell is so connected that light intensity is indicated directly

PHOTOELECTRIC CELLS

The tiny cell is used in talking "movies"—large one in radio picture transmission



MORE SINGLE CRYSTALS

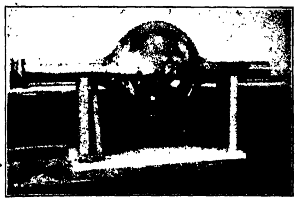
Top: *Single crystals of copper.* Lower: *Crystals of zinc, lead and cadmium*

GIANT TUBE

The "works" of a 100-kilowatt radio transmitting tube. The filament, made of tungsten wire, is eight feet long and about as large in diameter as the lead of a pencil

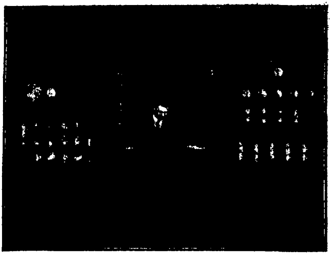
CATHODE-RAY TUBE

The largest cathode-ray tube that has as yet been constructed. The bulb is 20 inches in diameter. For comparison, a 15-inch rule is shown in the photograph, standing upright near the left support. The smallest X-ray tube rests at the base of the support. This type of tube is extensively employed for dental work. It works at low power ➤



Where Science Problems Are Solved

is the development of the radio vacuum tube, ranging from the tiny tubes used in dry-cell operated radio receiving sets to the giant water-cooled tubes employed for transmitting and capable of handling power up to 100 kilowatts. Each and every type of tube has its own particular purpose, and therefore presents different problems to the research scientist. The solving of these problems often leads to widely diversified fields and require the building of special apparatus. To supply these needs, special shops for the construction of apparatus of unusual design have been established and fully equipped. For example, note the glass-blowing shop illustrated above. Here the enclosures for all kinds of vacuum tubes and other apparatus are built to order. Special furnaces such as the one illustrated on the opposite page are employed for various purposes, such as the study of metals and their alloys. Many substances which find wide application in industry are the result of experimental work of this type. Who can say what will be the next startling invention which will be brought forth from these workshops of science?



AS IT WAS

The first transmitter used at station WJZ when it was located in Newark, New Jersey, in 1921. The engineer is checking the wave with a wavemeter. Note the phonograph on which the meter rests

AS IT IS

Part of station WJZ, now located at Bound Brook, New Jersey. The oscillator and modulator tubes shown are part of the 50-kilowatt installation now being used for transmission by that superpower station

A Radio Pioneer Steps Onward

Should Listeners Welcome or Fear KDKA's New Transmission System?

By ORRIN E. DUNLAP, JR.

THE old adage that "it is darkest just before daylight" has been applied often in the realm of radio. The ether over the United States was so congested when the Federal Radio Commission came into power that it found broadcasting in a state termed "chaos." There were 735 transmitters pumping entertainment into space. Many of the waves overlapped. The result was squeals, howls, voices and music all intermingled.

The commissioners studied the situation and soon compelled stations to share waves and divide time on the air. They drew charts to prove visually that there is not enough space between 200 and 550 meters for more than 400 transmitters to operate simultaneously in this country. The separation between waves was ordered to be 50 kilocycles in New York and Chicago, while in less congested zones the spacing was left at 10 and 20 kilocycles. Three hundred applications were on file in Washington waiting for permits to begin broadcasting or to build a station. The situation looked hopeless. It was a "blue Monday" for many stations when they were ordered to share their waves. Some protested.

Two broadcasters in Iowa asked through their microphones that a million listeners write to the Radio Commission requesting that the stations retain their two channels. The first mail the next morning brought 3326 letters, and before these were opened the second mail came with another flood, all from listeners of the two Iowa stations. The number of letters presented a stenographic problem for the limited staff of the commission.

THEN came the dawn with a new light in the announcement from Pittsburgh that the engineers of the Westinghouse Electric and Manufacturing Company had devised a new system of "broadcast transmission of such far-reaching effect that apparently closed fields of radio progress are now opening to future explorations." In the new system, the frequency band has been cut to one half kilocycle, which means that broadcasters can operate within one half kilocycle of each other. Greater significance was attached to the announcement by the declaration that KDKA, the pioneer broadcaster, was using the new system with success. It was KDKA that began broadcasting for the first time on November 2, 1920. Hundreds followed in the wake of the first waves from Pittsburgh. Today others are keeping a watchful eye on KDKA, wondering if the pioneer again is blazing a trail into a field of radical improvement. Some say "yes" and some say "no."

WATER-COOLED TUBES

A bank of vacuum tubes used for transmitting over the trans-atlantic "talk-bridge," which uses the amplitude system of modulation with the carrier and one side-band suppressed

Engineers explain that there are 950 kilocycles in the broadcast band between 200 and 545 meters. Therefore, it is estimated that with a system which enables one half kilocycle separation, approximately 1900 broadcasters can operate simultaneously without sharing waves or splitting time. Furthermore, all stations could have exclusive channels should such a system be adopted on a national scale.

It has been reported by

C. W. HORN

Mr. Horn is director of operations for the company which owns station KDKA. He is experimenting with frequency modulation

listeners during the weeks in which the system has been in operation at KDKA that the waves tune very sharply at nearby points, even while the transmitter radiates as much as 50,000 watts. Auditors in Michigan, New York and New England have reported that the signal strength is stronger than when the ordinary method of transmission is employed.

All modulator tubes are said to have been eliminated at the Pittsburgh station. This means a saving of twelve ten-kilowatt water-cooled tubes. These tubes cost about 175 dollars each and have short lives. In the usual methods of broadcasting, half the total energy is estimated to be absorbed and dissipated as heat, amounting to 80,000-watts, or approximately the power required to light 2000 ordinary incandescent lamps. This energy is now saved, and can be made available to increase the power of the transmitter if desired, according to the Westinghouse announcement.

"So radical is the departure from present methods of broadcasting that the engineers hesitate to forecast the great improvements in transmission that apparantly will result from the general application of the system," said the company's statement. "It is important enough for the present that these new fields of radio endeavor have been opened wide for further development."

The engineers define the system as "frequency modulation." They say that it is a revolutionary departure in nearly all respects from the generally used method of "power modulation." It is explained that a ten-kilocycle separation between stations will be required with the present type of radio receivers, which cannot tune sharp enough to take full advantage of one half kilocycle separation which the frequency modulation is said to afford.

"THE system has unprecedented operating efficiency," said the announcement. "It eliminates three quarters of the transmitting tubes at KDKA, permits the broadcasting of a wave many times sharper than heretofore possible, and provides the range and quality of transmission with less than half the usually required power input. It is regarded as extremely important in offering a practical solution to many problems of transmission, including the possibility of great reduction in station interference. It opens up a field in which engineers foresee an opportunity to overcome static and local interference."

Listeners in the vicinity of western Pennsylvania are said to have noted an immediate effect in the lifting of the blanketing effect that usually surrounds high-power transmitters. The improvement is credited to the sharpness of the radiated wave. The engineers explain that by this system,

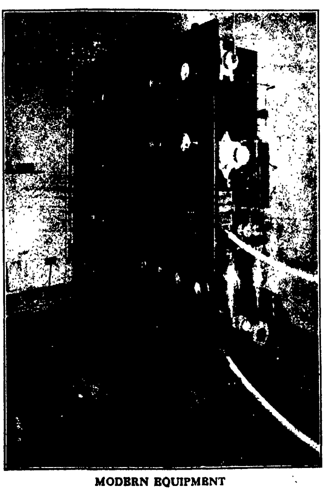
FRANK CONRAD

Mr. Conrad has been with KDKA since it first went on the air. Like Mr. Horn, he is experimenting with frequency modulation

instead of varying the amplitude or strength of signal, as is the present practice, KDKA is maintaining an even, constant strength of signal while the frequency of transmission varies by a very small amount—usually not more than 500 to 800 cycles.

The heralding of a new system of transmission came as somewhat of a shock to the radio industry. There is always a certain element in the radio field, as in all youthful undertakings, standing ready to point to the "revolutionary developments," and in many cases improvements have been labeled as "revolutionary." Manufacturers of receiving sets became very much alarmed, because they are well aware that the public numbering millions has fought shy of radio, always waiting for the "revolutionary developments." When the KDKA announcement was made, there were some who predicted the crumbling of the current broadcasting structure and the discarding of receiving sets for new and more efficient models. Such is not likely to happen. A new transmission system could not be put into effect "over night," unless it allowed reception by existing receivers, otherwise the audience of the broadcasting stations would dwindle to small numbers, because 6,000,000 radio set owners would not rush to buy new sets.

Broadcasting stations today use what is known as the power or amplitude modulation system, while the KDKA development is based upon frequency modulation. Neither system is new. In



MODERN EQUIPMENT

The new transmitter recently installed at station WBZA, Boston, Massachusetts. Compare this photograph with the one of the first installation at station WJZ, reproduced on page 320, and with the illustration of the original WGR, found on page 322

SHORT WAVES

This is one of the experimental transmitters that has been installed at station KDKA for the purpose of establishing contact with foreign lands on the shorter wavelengths. Work of this kind has been highly successful, particularly that done by the amateurs, who, with very low powers, have found it possible to cover enormous distances. Many of them have communicated with foreign stations, using different short-wave bands

fact, frequency modulation was utilized by Professor Reginald Fessenden a score of years ago and by many experimenters since that time. It is safe to say that a radically new transmitting system has not been discovered, but it is entirely possible that the experts at KDKA have made great improvements in the old method. Since the initial announcement, an air of mystery has blanketed the developments at KDKA. Nevertheless, a careful analysis of the situation makes it apparent that there is no ground for fear that the purchaser of a radio receiver this fall is doomed to disappointment because of a new system of broadcasting. Who would pay for scraping the 600-odd transmitters now in operation and the 6,000,000 receiving sets? How many radio set owners would spend a hundred dollars or more for a new set if their present receivers were made obsolete? The days of radical changes in radio are over. Improvements will come for sure but all big changes will be gradually slipped into the system so as not to disturb it or annoy the vast audience.

All fear of a revolutionary shift is dispelled by radio engineers and physicists, many of whom agree that nothing can be gained, as far as increased satisfaction of the listener is concerned by converting the present system of transmitting and receiving into a frequency-modulation system. Such comments are made, however, with reservations, because even the far-sighted scientists are not willing to predict what will happen in radio five years hence.

In commenting upon the frequency-modulation method, a prominent radio engineer said, "I do not see one single advantage to be gained. The contenion that the initial electrical energy at the transmitter can be reduced greatly is not substantiated by the findings of all engineers and physicists. I doubt if less power is needed at the transmitter to produce a given signal strength in receivers through the utilization of frequency modulation. Interference and static conditions would be no better under a complete system of frequency modulation than now experienced under our present system of amplitude modulation, according to my observations and the experiments of other investigators. A receiver built to respond to transmissions of the frequency-modulation type would be very inefficient when utilized to detect signals of amplitude modulation, which is now in general use throughout the world. Conversely, a receiver of the present-day type is not adapted to reception of frequency-modulated broadcasts."

JOHN R. CARSON, physicist in the research department of the American Telephone and Telegraph Company in a discussion of the theory of modulation before a meeting of the Institute of Radio Engineers said:

"It has been proposed a number of times to employ an apparently radically different system of modulation as distinguished from amplitude modulation, in the belief that frequency modulation makes possible the transmission of signals by a narrower range of transmitted frequencies. This belief is erroneous; the suggestion is, however, quite ingenious, and the reasoning on which the supposed advantage is based is very plausible, and indeed requires some mathematical analysis before its incorrectness can be satisfactorily established. A mathematical analysis shows, however, that the frequency band which must be transmitted is at least equal to that required in amplitude modulation. It is proved that the frequency-modulation system using a spacing or compensating wave is inferior to the amplitude system both as to width of the frequency band occupied and as to distortion of signal wave-form."

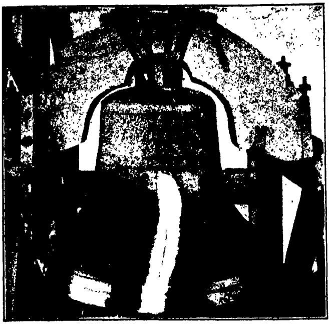
Dr. Lee de Forest, inventor of the three-element vacuum tube, in commenting upon the KDKA system said:

"I have felt that in time we would come to compound tuning as a solution to the problem of too many stations broadcasting on the present-day bands," said Dr. de Forest. "Such a system is not substantially new if it is the same as that employed by Professor Reginald Fessenden from 1901 to 1908.

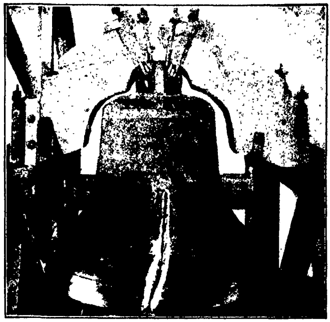
"The carrier wave of a broadcasting station alone requires less than one half kilocycle separation to avoid interference," explained Dr. de Forest. "On this carrier, a high-frequency modulated wave of the order of 30, 40 or 50 kilocycles may be imposed, which carries exclusively the modulations corresponding to the speech or music. These modulator frequencies, remote from the frequency of the carrier wave, may be arranged very easily so that no interference will result between the stations. In fact one station might radiate two or three such high-frequency carrier waves with an individual program on each wave, all at the same time. One program might be a lecture, one a symphony orchestra and the other a concert of a lighter nature. However, this system would entail rather complicated and expensive receivers, but it would be one possible way to overcome congestion in the ether. The receiver might be equipped with a three-way switch, so that the listener could select the program desired after the set is once tuned to the unmodulated carrier wave of the station."

LONG AGO

This is the way that broadcasting stations were built in the days when station WGR first went on the air. Everything is laid out so that it will be accessible for repairs, and in those days, repairs often were necessary. The two tubes, the heart of the transmitter, are mounted horizontally in the center of the table. Just to the left of them are the tuning inductances, the one of these on the right having adjustable solenoids

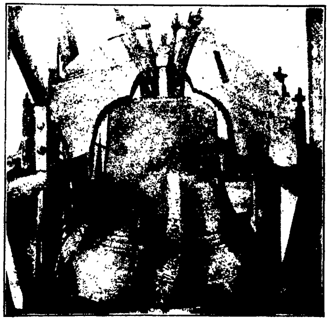


PREPARED FOR WELDING



OPENING THE CRACK

BUILDING UP



COMPLETED

ation is essential. All must be done expe-
he bell will not lose too much heat

Out of the Silence Comes a Voice

After a silence of over 40 years, a 922-pound bell in the First Unitarian Church of Taunton, Massachusetts, was repaired by electric arc welding. It now rings apparently as well as before the break. The church was founded in 1637, the bell being cast in 1804 by George Holbrook, who learned his trade as an apprentice to Paul Revere. The crack was discovered in 1886 and since that time no attempt has been made to utilize the bell. However, for two years there had been agitation to repair the bell. The General Electric Laboratory, at Lynn, Massachusetts, where much original research is now being done, was called upon for assistance. Specimens of the metal were taken and an investigation of the crack was made. The bell is 34 inches in diameter at the mouth, 18 inches in diameter at the top and 26 inches high. The crack was 17 inches long and had a section varying from one inch in thickness to two and five eighths inches maximum near the outer edge. The metal was found to contain 83 percent copper and 17 percent tin. Some interesting problems were therefore to be solved. After the crack had been prepared for welding, a standard motor-generator, constant-energy type of welder was employed in the actual welding, an electric power line having been installed in the belfry, 56 feet from the ground. Power lines were run down from the belfry to the welding outfit on the ground, and the welding leads were extended up to the bell. The operator started with the carbon-arc type of welding, and finished with the metallic-arc process. Phosphor-bronze welding rods were used, having an analysis of about 95 percent copper and 5 percent tin.

Africa

The Impressions of a Modern Woman, After Two Years Spent Among the Natives in the Jungle

By MARTHA MILLER BLIVEN

The Author

THE struggling locomotive puffed, coughed, gasped—and died. My husband and I, a couple of greenhorns in the ways of Belgian Congo trains, gazed out of the windows over an uninhabited and barren country, and wondered when we would be moving on. It was to wonder! We sat like this for hours, watching the heat-waves dance above the hard-baked ground around us. A blasé fellow-passenger informed us that these trains were always anywhere from an hour to a day late in arriving at their destinations.

It began to grow dark; and restless passengers strolled back and forth the length of the train. Several Englishmen thought that they would like a game of bridge to while away an hour or two. They borrowed the engineer's lantern and began their game on an old box placed near the train. The second hour passed—and still no signs of motion on the part of the locomotive. A crowd gathered about the informal bridge table for amusement—and the black engineer was among the interested audience. Another hour passed. One of the weary players, looking up, "spotted" the engineer.

"How are you ever going to have that train in motion when you stand here watching us?" he asked.

"Oh, the engine is fixed and all ready to go; I am just waiting for you to finish your game so that I can have my lantern to wave while I call 'all aboard.' "

This was truly Africa, where time was of no importance to the native. Here was a country where the hurry and bustle of the foreign world was forgotten. The two-day train trip from the West Coast port, Matadi, to Kinshasa, the town on the lowest navigable portion of the Congo River, should have warned new-comers of this situation, but I fear that they understood it much better when they made their exit from the country after several years of living and learning than their optimistic minds would let them grasp at first.

On an old Mississippi stern wheeler, which moved slowly along in the daytime and tied up at some native village to "sleep at night," we traveled upstream for 28 days—the entire length of the navigable portion of the Congo River. In one place, the Congo is less than a quarter of a mile wide, while in another section it is over 25 miles wide.

Because of its great size, the Congo River is an international waterway where you see boats flying the flags of England, the United States, France, Belgium, Italy and Portugal.

Along the Congo and its tributaries the crocodile is considered an evil spirit. When a native is knocked into the water and drawn under by a crocodile, it is surmised by the rest of the village that it is the evil spirit that is following his family, demanding a sacrifice. Many a crocodile that has been shot and cut open has been found to contain brass and copper armlets and anklets.

Naturally, the crocodiles are considered vermin in this country where they exact such toll from human life. So we felt no scruples in practicing shooting with crocodiles as targets. During the dry season the waterways were dotted with sand banks on which the crocodiles were lying and sunning themselves. It was easy enough to hit them, but nine times out of ten they managed to get into the water before they died.

One day, however, when we were traveling on a small steamer, I was fortunate in breaking the backbone, high in the shoulder, of a crocodile. Then it could not flop from the sand bank into the water. The Danish captain obligingly stopped the boat so that we could put off in a small craft and bring the "croc" on board for closer inspection and to be skinned.

There was lively interest expressed by the black crew at this episode to break the monotony of the day. One old native began telling us the history

A Woman Explorer

THE versatile author of the accompanying article was for several years secretary to Carl Akeley, the great naturalist and sculptor whose untimely death was noted in our issue for March, 1927. Martha Miller Bliven was taught to shoot by Mr. Akeley, and she soon became a first-class hunter of big game. She also assisted him in his literary work. In the present article she describes the colorful life which she and her husband found in this wonderful continent. We are fascinated and made not a little envious by her story.—*The Editor.*

PYGMIES OF EAST BELGIAN CONGO

These pleasant little people danced all one long Thanksgiving Day for a spoon of salt. The dance is largely made up of "shimmying"

TESTIMONY OF THE HUMAN YARDSTICK

Little Alice Bradley, age five, is posing with two adult pygmies, so we can be certain that they are of the size usually attributed to them

A FALLEN MONARCH OF AFRICA

Here we find the author considering the best way of taking care of one of her best prizes, a splendid example of the African lion

ELEPHANT HUNTING IN BELGIAN CONGO

Mrs. Bliven and Carl E. Akeley are shown discussing our author's well-placed shot. An elephant is not an easy animal to kill

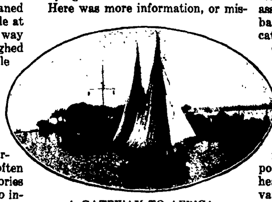
of all crocodiles, their habits and customs. Of course, it was told in the Bangala language, which, fortunately, we had learned to speak and to understand.

From the flow of words we gleaned that a crocodile swallowed a pebble at every new moon, and this was his way of keeping tab on his age. I laughed at this as I had a vision of a crocodile dying of old age because he had swallowed so many rocks that he could not wiggle.

However, we were interested. Experience with the natives had taught us that they know a great deal about the anim alsin their particular regions, and that there is often some truth behind the fantastic stories that they tell you. We decided to investigate this fable (for I had never heard a story like this one in South Africa or in East Africa). Albert did the skinning and the carving, while I became the spellbound audience. And now, believe it or not, when that crocodile was cut open, his stomach yielded more than 300 pebbles of different shapes and sizes. A tall "Hauser" native, of Arab strain, asked for these pebbles. When I inquired what he wanted to do with them, he replied in the following startling way:

"I wish to put them in a bottle of water to make medicine. This medicine is a cure for natives who have sleeping-sickness."

Here was more information, or misinformation, as the case might be. As we were in a tsetse fly area then, and as the subject of sleeping-sickness was especially interesting, I decided to send the pebbles to a prominent physician in New York to be analyzed. This resolution on my part never materialized, as it was several weeks before we reached a post office. By that time, the increased strength of the odor of the pebbles so offended my nose that I threw them away in disgust.



A GATEWAY TO AFRICA

The entrance to the Suez Canal is far from being as spectacular as that of the Panama

THE AUTHOR'S CROCODILE

On the Ebangui River crocodiles afford an easy mark, yet they often escape before dying. A rifle shot broke this one's back

THE second year of our sojourn in Central Africa was spent in French Equatorial Africa—a most interesting year—and a delightful change from the year of meandering the Congo River and its many tributaries in the Belgian Congo. Also, my young sister-in-law, Ann Bliven, joined our party. She was such a true sport, a charming companion, and so enthusiastic about all she saw and did, that Africa seemed to respond to her praise by betraying to us its most fascinating side—the true bush life of Africa.

Every day was like a page out of an interesting book. We encountered the real natives, unspoiled by the touch of civilization; we learned about the different birds and flowers; we photographed and hunted wild game in its natural setting; we visited tribal dances and funerals; we doled out medicine and dressed wounds and ugly sores; we studied young animal life from close association with our pets in camp—baby monkeys, young leopards, serval cats, and so on.

Our routine of camp-life changed completely. Now all equipment of tents, cots, blankets, provisions, medical supplies, ammunition, photographic and developing kit, clothing, table-ware, kitchenware, and money was packed in boxes which weighed, when packed, not more than 55 pounds each. The porters carried these loads on their heads day after day; and our marches varied in length from 15 miles to 25 miles a day.

To these "beasts of burden"—and I might add that they were a fairly happy and contented lot—we paid two cents a day per man. Or, if we were staying in one district for any length of time we hired our 60 porters at 50 cents a month per man. Each porter furnished his own food and looked out for himself. Of course, when we were in a game country we shot meat for their food, of which there was never a

DEATH OF A WART HOG

This ugly looking animal abounds in the Belgian Congo and his death caused no regrets. His flesh made excellent eating

particle of flesh wasted. The insides of the animals were quite as delectable to the native as the outside meat; and I can assure you that the hyenas, the safari ants and the vultures had "poor pickings" when the porters departed from the skeleton of a recently killed antelope, buffalo or elephant.

WHEREVER we stopped for the night, or to camp for a few days, that spot was referred to as home. Therefore, it was made comfortable. In fact, it was camping *de luxe* compared with the "roughing it" trips one takes in America. There were plenty of personal servants—boys of varying ages and sizes and tribes—to wait upon us, to prepare warm baths in portable tubs, to clean boots, to keep the tents neat and to prepare and serve meals.

I was often annoyed and later on amused at the antics and the stupidity of some of these boys. One little tent boy in particular, Pambu, managed to annoy me more than the others, but he was so funny that we kept him with us for the 27 months that we spent in Africa. He enjoyed eating the tooth paste—a valuable and irreplaceable article of necessity—and on numerous occasions he was caught scrubbing out the wash basin with a tooth brush. I never realized how attached I had become to this stupid, loyal little scamp until it was time to say "Good-bye" and to turn over my wornout possessions that he desired as presents. I felt like weeping when we parted, and he said:

"*Nquenda malamu, madame*"—"A good journey, madam"— with tears in his eyes.

Of course, the kitchen and what to eat was a problem, as it is anywhere. During the second year of our stay in Africa, the food began to have an appaling sameness of taste. In all fairness, though, I think the cook did extremely well, inasmuch as he cooked the meals over an open fire surrounded by three hot stones. When he wanted to bake bread or make a cake he built a crude oven by tunneling through an uninhabited, hard-baked ant hill. Then he filled the cavity with glowing embers, placed the bread tins among the live coals and closed the openings he had made on both sides of the ant hill. For yeast for the bread, he used a bit of banana pulp which had fermented in the sun. This he kneaded with some dough, kept it in a warm spot, and referred to it as the "mother of the bread."

A TYPICAL AFRICAN TREE

The table-top acacia tree illustrated above is one of the unusual and distinctive features of African scenery

I soon discovered that the real necessities of life took care of themselves, or were worked out for you by the natives, and the things that I had always considered as "absolutely necessary" at home were not necessary at all. After all, it is only your point of view. Without doubt, we were comfortable, had good appetites, had very little sickness, and the fact that we are anxious to return to Africa is ample proof that we enjoyed it and found life very interesting there.

"But what did you eat?" I have been asked.

As a matter of fact, our meals usually were very similar to those we would have had at home, except that all of the milk, butter, jams and most of the vegetables were tinned. Our fresh fruits consisted of bananas purchased at ten cents per bunch, oranges at 20 cents per hundred, avocados at about the same price, pineapples at one cent each, and so forth.

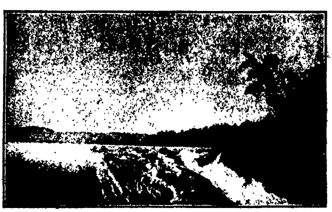
On several occasions we strayed far from our base of supplies and stayed away longer than had been anticipated. Of course we ran out of tinned foods, but this condition never hurried our return, as we always managed to live off the country very well. For instance, wild honey replaced sugar, native potatoes and rice were obtainable and game was plentiful. Mushrooms the size of a luncheon plate were found to be very edible, while the hearts of young pineapple plants or of young palm trees afforded a refreshing salad.

Of the animals that we shot, we tasted nearly all. We had the brains of the buffalo sauté, the heart of the buffalo fried and the warm marrow from the heated leg bones. Of the antelope we generally used the tongue and the tenderloins, giving the remainder of the meat to the boys and the porters. From the wart hog the cook prepared roast tenderloin of pork.

TO change the meat diet, wild ducks and guinea-fowls tasted delicious. Of the meats that I ate but did not enjoy so much, as my imagination played tricks on me, were gorilla flesh, the heart of the lion and the trunk of the elephant. We absolutely drew the line at eating python-snake steak, even though the natives assured us that it was palatable.

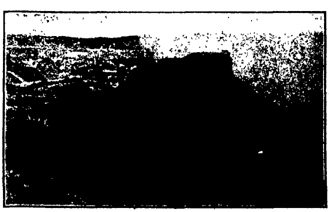
Now, when I am crowded into a subway and am jostled and pushed about, I find that visions of Africa—the freedom, the thrill of exciting moments, the fascination of unspoiled Nature, of game—appear tempting to me and blot out the unattractive scenery before my immediate vision.

One of the "high spots" of our expedition will always remain vivid to me: the moonlight nights when we watched the night life of the plains while waiting behind a thorn screen "boma" for the lions to come to feast upon a dead antelope staked about 15 feet in front of us. Discernible in



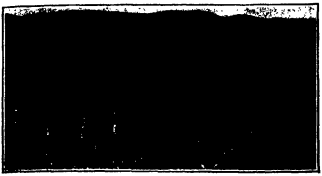
BIRTH OF THE NILE

The Nile proper is shown at its outlet from Lake Victoria Nyanza, from whence it flows to the sea, a distance of 3473 miles



INSIDE THE CRATER OF A VOLCANO

In some of the volcanoes of Africa it is possible to go down into the crater even though the cone, shown in the center, is active



THE FOOD LINE

Bananas are one of the principle foods. A strong and potent alcoholic beverage is also made from this innocent appearing fruit

GRAVE OF LION'S VICTIM

Under the cross of this grave lies the body of an Englishman who surrendered his life to the inexorable laws of the African jungle

the distance were the outlines of the sentinel antelope standing guard against a surprise attack of the antelope's enemy, the lion.

In the immediate foreground the hyenas, jackals and serval cats pulled and gnawed at the dead antelope. Nervously they darted in and out of the surrounding shadows as if they

THE AUTHOR'S CAMP PET

This sleepy little year-old leopard was not taken back to civilization

were on the alert for the arrival of their foe. From a distance to the right of us came the grunt of a lion as he picked up the blood trail of the antelope. There is some resonant note in the grunt of a lion that sends little prickling needles of excitement up and down your spine. Hastily the cat family faded from view. The greedy hyenas and jackals put their teeth into the flesh for one last tear before they, too, slunk off into the shadows of the brush.

For a time, only the thud of the galloping herds of antelope could be heard as their hoofs beat upon the hard-baked ground. Then all was quiet. Not a sound nor a crackling of a twig broke the surrounding stillness. Behind our thin screen we were expectantly quiet. I was tense as I placed my hand near the trigger of my gun, for all signs indicated the approach of the lion for which I had been waiting up and watching for five entire nights.

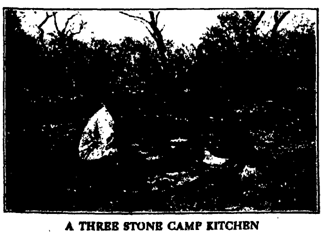
FROM the shadow of the brush emerged the silhouetted form of a lion—no longer were his grunts heard, for he was stalking his prey and went about his time-old game in a cautious and silent manner. So quietly did he slip from the shadows into the scenery before my eyes that I could hardly believe it. He halted just in front of the boma and looked cautiously about him. He sniffed at the bait, then looked in our direction. I dared not wait longer. There was a flash and a roar from my Springfield and the lion fell beside his prey.

It was out of the question to examine him then, as it was unwise to leave our posts. However, we could flash a light upon him to be sure that it was really a dead lion and not a myth of a moonlight night. At the first rays of the morning sunrise, we crawled stiffly through a hole in the thorn screen so that we might examine the trophy, stretch our weary bones and have breakfast.

A "BEAUTY" TREATMENT

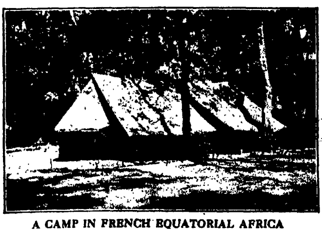
A tribal marking which is much esteemed is inflicted with hot rubber

My lion proved to be a good specimen of the plains variety, weighing more than 400 pounds and possessing a splendid coat and mane. The tick bites I received and the annoyance of the mosquitoes and the stiffness from a cramped position quickly passed, but I shall never forget those tense and interesting magic nights of watching and waiting on the plains of that fascinating continent—Africa.



A THREE STONE CAMP KITCHEN

The servant problem presents no terror in Africa. This cook costs 8 dollars a month, with the little dishwasher, and they feed themselves



A CAMP IN FRENCH EQUATORIAL AFRICA

Mrs. Bliven refers to camp life in her article. Most of the comforts of home are provided. Fifty dollars a month pays all expenses

Successful Inventors—X

A College Professor Solves a Mathematical Problem and Becomes a Wealthy Inventor

By MILTON WRIGHT

MOST of us are likely to think of an inventor as eagerly seeking some idea upon which to exercise his genius, and then bending over a work bench surrounded with wheels, wires and miscellaneous gadgets trying first this combination and then that until he works out his invention. He gets his patent and makes the rounds of manufacturers, all save one of whom laugh at his radical ideas, but that one sees something in it and makes a fortune.

The other day we were talking with an inventor who is not like that at all. He never thought of himself as an inventor, never looked for anything to invent, never had any intention of making a lot of money, believes he is weak in imagination—that quality so often considered necessary to successful invention—has put in far more time writing a book than he has done in inventing, has done his inventing only as a sort of side line and never bothered peddling an invention around among manufacturers. All the inventing he does is with a pen and a note book. And yet Louis Alan Hazeltine has made a fortune out of his inventions. The best known of them, of course, is the Neutrodyne radio receiver.

THAT there was a fortune in the Neutrodyne is not surprising. You recall the confusion in the early days of broadcasting. You would be enjoying a concert on the air when a long shrill squeal would drown out all the music. The trouble was due to the fact that most receiving sets were of the regenerative type. Each receiver was in reality a miniature transmitter and when they were improperly handled—as they generally were—complications were sure to arise. Manipulation of the dials to get the best results quickly meant the sending out of waves which were picked up by other receivers. In crowded neighborhoods there was a continual squealing as listeners were tuning their sets or "fishing around" for distant stations.

Then came Hazeltine with his Neutrodyne and the trouble disappeared. Radio receivers became highly sensitive, reception was under complete control and, because of this control, squealing became impossible.

"What would you say, Mr. Hazeltine, is the secret of successful inventing?" we asked.

"That is a hard question," was his reply. "It is especially hard for me, because I work differently from most inventors. I believe, however, that the first requisite is a thorough knowledge of fundamental principles.

THE INVENTOR AND HIS TOOLS

Louis A. Hazeltine does all his creative work with a note book, a fountain pen and a slide rule, thus avoiding trial and error methods

"I never had any intention of being an inventor. Mathematics was always my favorite subject in school; it was in mathematics that I used to get my highest marks. When I entered Stevens Institute of Technology I thought that eventually I would like to get into teaching.

"What I wanted to take up I had no idea, but I was prejudiced against electrical engineering. Near the end of my course I began to feel that the performance of electrical apparatus could be predetermined more accurately than that of mechanical apparatus. Here was plenty of opportunity to work out mathematical problems, so I took up electrical engineering in spite of my former prejudices."

From Stevens he graduated in 1906. Usually elementary school, high school and college take 16 years of a young man's life. Hazeltine, however, did them in 12. Leaving Stevens, he entered the testing laboratory of the General Electric Company in Schenectady. A year later he took a position as assistant in the Department of Electrical Engineering at Stevens Institute. On that college's staff he remained until two years ago.

In 1915, E. H. Armstrong read a paper before the Institute of Radio Engineers on the fundamentals of the three-electrode vacuum tube and in particular disclosed the tube's capabilities for regenerating and oscillating. It opened for Hazeltine a field for complex mathematical analysis in which he could revel to his heart's content. He began a theoretical study of the vacuum tube's operation and worked out the theoretical requisite for producting oscillations. Then, for the first time, he obtained a vacuum tube and traced its characteristic curve. With all the necessary information assembled he designed and wired his circuit. In practice it worked out exactly as it had on paper, and oscillations were produced on the first trial.

FOR two years more he continued his theoretical studies, using actual experiments from time to time only to verify his calculations. In 1917 in a paper on "Oscillating Audion Circuits" he gave the Institute of Radio Engineers the results of his work. For the first time a general yet simple mathematical method for the treatment of oscillating audion circuits was stated. All of Hazeltine's later work in radio he traces to that paper.

"How did you come to take out your first patent?" we asked.

"In 1917," he replied, "I was experimenting with Paul Ware, one of my students, on wireless telephony. The result obtained looked practical and I took out a patent and assigned it to him on a royalty basis. The invention was used later in the Army Signal Corps for wireless telegraphy."

"And that really started you on

the pathway to becoming a patentee?"

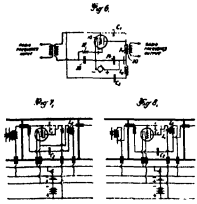
"No, I wouldn't say that. That was more or less an isolated invention. In the World War I joined the technical staff of the radio laboratory at the Navy Yard at Washington. There I designed a radio receiver which the Navy standardized and which came into wide use. My superior officers asked me to prepare patent cases on what I had done; that is how I really began to apply for patents.

"I began to devote my time to a study of the application of three-electrode vacuum tubes to the various problems of converting power; efficiency, of course, was the primary object. In the fall of 1922 my attention was directed to the tremendous possibilities of a receiver using tuned radio-frequency amplification. The limitation of this type of receiver which had prevented its becoming a success, was the fact that it had a tendency to oscillate due to the feed-back of the vacuum-tube's capacity coupling. Tuned input and output circuits accentuated this feed-back. My earlier work on the neutralization of this capacity coupling was directly applicable. A model receiver was made. It became known as the Neutrodyne.

"RADIO broadcasting was developing rapidly and manufacturers were seeking eagerly for a receiver that would do just what mine would do. A year after the Neutrodyne came out, a corporation known as the Hazeltine Corporation was formed and I sold my patent rights to it, partly in exchange for a substantial stock interest."

"Would you advise an inventor to go into the manufacture of his invented articles?" we interrupted.

"No," he replied. "Usually an inventor is lacking in commercial ability. Generally someone else doing the manufacturing can make more money for him than he could for himself when working alone."



PICTURES WORTH A MILLION

Upon these drawings the Government allowed claims which made the inventor rich

"And which would you say is more profitable for the inventor: an outright sale of his patent or leasing the patent on a royalty basis?"

"That depends more on the purchaser than it does on the inventor. While it is a pleasant thing to be paid a lump sum in cash, still there might be more in the long run in a royalty. However, the inventor as a rule is not in a position to dictate.

"Sometimes the financial circumstances of an inventor have a lot to do with how much he gets. For several years before I developed the Neutrodyne I had been in consulting practice. This had been fairly lucrative and I felt reasonably independent. If an inventor is hard up he may feel obliged to let go of his invention for a fraction of its value."

"What steps do you think an inventor should take to protect his invention?"

"My advice would be to get a high-grade firm of patent attorneys and follow their advice. The Patent Office recommends such a course, you know. When I was ready to patent the Neutrodyne I went to a former student of mine who had joined a well known firm of patent attorneys.

"You must remember that I do not hold myself out as an example. Every man has to work in his own peculiar way. I have always thought of myself as a teacher rather than as an inventor and I conducted classes regularly. I was accustomed to think of an inventor as rather impractical. I gained this impression from the many inventors who came to me for help and advice; most of them I thought were foolish. Now that I have stopped teaching and am devoting all my work to inventing I suppose I have to call myself an inventor."

"BUT all the time you had been training yourself for invention."

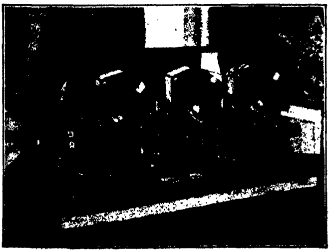
"That is true. For anything I have been able to accomplish a thorough foundation was necessary. I spent years in theoretical investigations. The time I spent on physical engineering problems was enormous, and it is surprising how many of the principles and methods I worked out proved extremely useful later."

"To be financially successful should not an inventor make a definite search for the right thing to invent?"

"I don't know. I have never been looking for new ideas and most of my work has not been done with any thought of money. I expected to spend my life as a college professor on a notoriously small salary, for I knew it was work in which I would be happy.

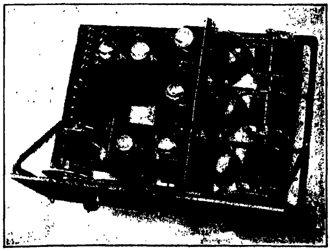
"Here is a text book on electrical engineering published some time ago. I spent vastly more time on that than I did on all my inventions and I think there is far better work in it than there is in the Neutrodyne, but as for money, well that is something different.

"That I have become an inventor probably is a logical development. I should say that if any man is a competent engineer working on new development work, he cannot help making inventions."



THE FIRST NEUTRODYNE RECEIVER

With this model there was no experimenting. It was all thought out in algebraic formulae, and when it was constructed, it worked



THE NEUTRODYNE OF TODAY

Lift up the cover of any one of ten million radio sets in use today and you will see this adaptation of Hazeltine's famous invention

Wide World

A COMPLETE TESTING PLANT

The author conducting a dynomometer test by his new method, which includes all the various considerations effecting efficiency, from the front wheels, through the motor and the driving mechanism to the tire contact

400,000,000 Horsepower!

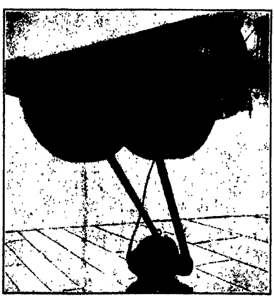
This is the Aggregate Power Developed by Automobiles Tests on 250 cars show some interesting results

By E. H. LOCKWOOD
Associate Professor of Mechanical Engineering, Yale.

THE development of the motor vehicle has afforded an example of the popular use of mechanical power on an enormous scale. In the United States alone over twenty million motor cars were registered in 1926, in units from 15 to 100 horsepower each, or an aggregate of perhaps 400 million nominal horsepower. The variation in power of these cars is considerable, but is easily explained by differences in weight of the vehicles, and in the road speeds for which they were designed.

The horsepower of motor-car engines usually has been determined by the "block test," on the electric dynamometer, of representative samples, before assembly in the chassis. These tests have rarely been made after the car was built, owing to practical difficulties in removal and replacement of the engine and other preparations, such as lining up the engine on its foundation, bolting a coupling to the flywheel or shaft, et cetera, all adding to the expense and trouble of this method of testing. But this method is a standard one and universally used. Moreover the mechanical efficiency of the automobile as an entire machine or the efficiency of the various subdivisions can readily be obtained.

Portable instruments have been devised for power tests on the road, employing in most cases the inertia of a heavy weight or liquid to indicate the acceleration of the car, from which the horsepower can be computed. These instruments have value for approximate measurements but are not comparable with the block test for reliable information.



THE DRIVING MECHANISM

FIGURE 1: *The traction pulleys are hung beneath the testing floor and have individual drives as shown. See also Figure 4*

The difficulties connected with block testing may be largely avoided by the use of a different kind of apparatus, known as the chassis dynamometer. While somewhat more elaborate than the block-test apparatus, when once installed the new method is far more convenient to use. A complete power test can be made in an hour or two without any dismantling of engine or chassis, thus making it possible to test the power plant of any motor vehicle with a minimum expenditure of time and trouble. In spite of its advantages, the chassis dynamometer has been but little used for engine testing.

A good example of successful use of this type of apparatus is to be found at the Mason Laboratory, Yale University, from which source the illustrations in this article have been obtained. Since this dynamometer was installed it has served for power measurements on hundreds of motor cars, including not only power of the engine but also the power lost in transmission and in the tires.

The principal part of the

apparatus, as shown in Figure 1, consists of two pulleys of large diameter, mounted on a rigid shaft and supported from the ceiling by ball-bearing hangers. The tops of the pulleys are exposed through openings cut in the floor, which permits the two rear wheels of the vehicle to be centered on the pulleys, while the car itself is securely anchored to prevent motion. When thus arranged, the engine can be started and run at any desired speed, delivering power through the rear tires where it is measured on the pulley shaft by suitable appliances.

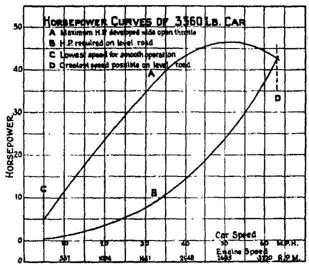
The operator's stand is shown in Figure 4, including a scale for measurement of torque and an electric tachometer for speed. Torque refers to the resistance to rotation of the pulley shaft, which is varied according to the desired load on the engine and is registered on the scale. Variation of the torque is effected by change of tension of a band of ropes encircling the brake pulley, produced by a hand wheel at the operator's table. The brake pulley and encircling ropes can be seen at the end of the drum shaft, Figure 1. This form of rope brake has been found in practice to be very flexible and convenient. The capacity of the brake system has been estimated at 140 horsepower, but thus far the greatest demand has been only about 110 horsepower. Its maximum capacity expressed in tractive force exerted at the pulley surface is 2000 pounds.

A minor part of the apparatus is a variable-speed electric motor belted to the main shaft, which ordinarily is not used and revolves idly with the pulleys. When desired, the wheels of the car can be rotated by the electric motor, for measurement of friction loss in the tires and transmission. Such friction measurements can be applied to both front and rear wheels, and give useful information as to power losses in the car.

FUEL measurements have been made by a special weighing tank having a flexible pipe leading to the carbureter, which permits of automatic measure of fuel weight and time for any run. An alternative device, suitable for full-power runs, has been a calibrated flow meter for instantaneous reading of the flow rate.

Engine cooling by the radiator and fan is insufficient in the absence of air currents such as are met on the road. The deficiency can be made up by adding a little water at the radiator drain cock, which produces a proportionate overflow of hot water from the upper tank. The practice at the Mason Laboratory has been to maintain a constant water temperature in the upper radiator tank of approximately 175 to 185 degrees Fahrenheit.

In testing a motor vehicle, it is important to know what tractive force delivered at the rear tires will propel the vehicle at constant speed, either on the level or an up grade. This information can be had from the general principle that the tractive force required at the rear tires must equal the sum of the resistance of the front wheels, plus that of the air, plus that of grade. Each of these resistances can be obtained, at least approximately. The front wheel rolling resistance can be measured on the chassis dynamometer. The air resistance can be computed from the car speed and body area, assuming still air. The grade resistance can be computed from the percent of grade and car weight.



THE STORY OF THE TESTS

FIGURE 2: *At full throttle a point is reached where increased engine speed diminishes the horsepower output just before maximum car speed is reached. See text for further explanation*

The power plant must deliver this tractive force at the rear tires. Indeed it must exert considerably more power than that delivered at the rear tires, since it must overcome all friction of gears, bearings, lubricant and flexing of tires before any tractive force can be applied to the road. The engine power may be divided into two parts—that lost in transmission between clutch and rear tires, and that delivered at the rear tires as useful tractive force for propelling the car. In chassis dynamometer testing it is necessary to measure these two power elements separately, considering their sum as the total engine power.

In testing a motor vehicle it is usually sufficient to run the power plant under two extreme conditions only. First, at the maximum power output of each of the possible operating speeds; second, when the load at each speed is adjusted to be the equivalent of that required on a level road. From its behavior under these conditions, the power-plant performance in intermediate states can be safely estimated.

ENGINE horsepower is difficult of direct measurement, but can be easily computed from the torque in foot pounds and the speed in revolutions per minute. When the engine is mounted in a motor car, a portion of the engine torque is lost in friction before reaching the rear tires, as before mentioned. Tests prove that the transmission friction loss increases slightly with the speed, and quite considerably with the power transmitted. Under average conditions it may be assumed that the friction of transmission under full load is 25 percent greater than under light load.

The light-load friction loss in transmission is easily measured on the chassis dynamometer at all speeds. The full-load friction loss is difficult of measurement, hence it is permissible to use an approximate value found by adding 25 percent to the light-load figures. There is some uncertainty attending the measurement of the transmission friction loss, but fortunately the friction loss is only a small portion of the total engine power.

Engine horsepower on the chassis dynamometer is necessarily measured in two parts: first, that lost in transmission friction, second, that delivered at the rear tires as tractive force.

An example of engine horsepower determination in accordance with the foregoing method, is given in the accompanying diagram, Figure 2. Part of the diagram, curve B, relates to the power required to drive the car on level road. This curve starts at about one horsepower at five miles per hour, and continues to 48 horsepower at 63 miles per hour when the maximum speed is reached.

Similarly, curve A relates to the greatest possible power of the engine, starting at about five horsepower at five miles per hour and reaching a maximum of 46 at 50 miles per hour. As before stated, the horsepower was computed from the car speed and the tractive force as measured at each speed.

The curves stop abruptly at point C, this being the lowest speed for smooth running in high gear. The curves A and B meet at point D,

THE BLOCK TEST

whose intersection determines the maximum speed on level road. Two scales are given on the abscissa axis, one referring to car speed in miles per hour, the other to engine speed in revolutions per minute. In this example, the car speed was 68 miles per hour, with a corresponding engine speed of 3400 revolutions per minute.

Diagrams similar to Figure 2 have been constructed for many cars, both light and heavy. A singular fact has been discovered from study of these diagrams, namely, that curve B has been approximately alike on all. It follows that high car-speed, as indicated by point D, can be had only by raising curve A, that is, by using a larger engine. The rapid rise of curve B at high speeds indicates that considerable increase of power will be required for even a moderate gain in speed.

INSPECTION of the curves shows that both have the common characteristic of increasing with the speed at a nearly uniform rate over the range from 20 to 50 miles per hour. It follows that the reserve horsepower available for acceleration, grades, head winds, et cetera, is nearly constant, and ample for prompt response to the driver's needs. Above 55 miles per hour the reserve power falls off rapidly to the maximum speed of 68 miles per hour where the reserve is zero.

Fuel consumption can be measured quite conveniently on the chassis dynamometer. Fuel economy of a motor car can be stated in different units, but is usually expressed in pounds of fuel used per hour for one horsepower. Measured on this basis, all engines are on a par, with minor differences produced by the compression ratio, carbureter setting, and internal friction.

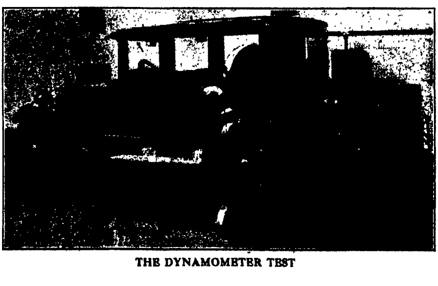
This economy unit is often called the "fuel rate" and its best value is about 0.5 of a pound per horsepower for gasolene engines. This value can be reached, however, only when the engine is tuned up for full-power operation, as in airplanes. Motor-car engines must perform smoothly at all speeds, must start and idle well, requirements that can be met only by a richer fuel mixture. In consequence, the fuel rate of automobile engines is barely lower than 0.70 to 0.80 of a pound per horsepower at wide-open throttle—that is, for the steepest grade that can be climbed. At part throttle, the fuel rate is considerably increased, and may reach values as large as 1.5 to 2.0 pounds per horsepower hour at very light loads.

Another measure of fuel economy is the number of miles that can be traveled on one gallon of fuel. This unit varies in magnitude with the car speed and with the grade, and values are usually stated for level and for steepest grade that can be climbed at each speed. Weight is an important factor in this unit, and the light car has the better economy, as is quite evident. For example, a motor cycle may travel 60 miles per gallon on level road, while a loaded truck may go but one twelfth of this distance—hence the fuel cost of running the truck is twelve times as much as that of the smaller and lighter vehicle.

THE miles per gallon may be determined on the chassis dynamometer by converting the fuel consumption into gallons per hour, and dividing the miles per hour by the gallons per hour. The actual miles per gallon for long trips on good roads should lie between 22 miles per gallon at light load to 5.5 miles per gallon at full load when running 10 miles per hour. At 50 miles per hour, the mileage is 15.3 versus 8.3 under the same conditions.

Experience shows that the miles per gallon obtained on improved roads, checks closely with the level road figure from the dynamometer test. This indicates that the up grades are offset by the down grades as far as fuel consumption is concerned, giving practically the same fuel consumption as on level road on a long trip.

Simultaneous count of revolutions of rear wheels and traction drums shows that tire slip is practically absent on a dry surface. On the other hand, there is a small but measurable creep of the tire due to the stretch of the rubber at the point of contact with the road. Due to this creeping action, the driving tires tend to gain speed when power is applied, and to lose speed when brakes are applied, resulting, practically, in zero displacement, since one creep offsets the other.



THE DYNAMOMETER TEST

PIANO CLASS TEACHING

The illustration shows a children's class being taught by the "Visuola." As the teacher depresses a group of keys, little lights flash up over the pupil's keyboards, showing the location of the note, its duration, sequence, fingering, and phrasing. The interpretation so unified appeals to the children, all of w'

DEMONSTRATION STAGE

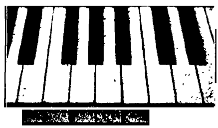
A large keyboard was installed so that the audience could follow the progress of the lesson. The teacher sat at the piano on the right and "dictated," by means of the little lamps, to the pupil on her left, who in turn flashed the notes on the great keyboard so that the audience could see the action. The notation was shown on a screen at the left. After ten minutes of instruction, the child alone played the piece that had just been learned "by electricity"

TRANSMITTING MECHANISM

Plungers rest on each key so that contact is made when keys are depressed

BULBS ON KEYBOARD

As the key is depressed, the same note on the pupil's keyboard flashes



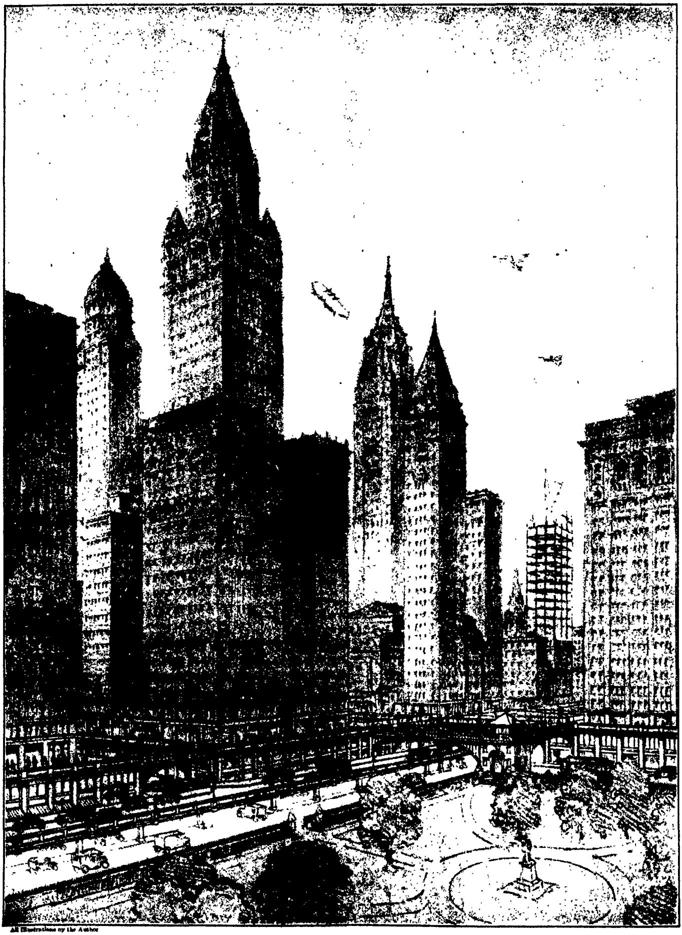
LIGHTS SHOW NOTES

White keys flash white, black keys flash red on the pupil's "lightboard"

Piano Instruction Aided Electrically

In the reading of piano music, there are a great number of facts that pertain merely to such mechanics as the names of notes, names of keys, lines, spaces, sharps, flats, tempos, expression marks, signatures, accidentals, et cetera. To play the simplest tune, the beginner must learn the names of the keys; the names of the notes; the values of the notes; the correct fingering of each hand; the use of the hands on the proper keys; to keep thought on the proper use of hands and body, and to correlate all of these. The approach to music through the door of the printed page cannot, therefore, lead the beginner deftly, swiftly, interestingly and with logical sequence into the heart of the playing of music, because it takes time to master the intricities of musical grammar.

Electrical science now for the first time enters the field of the art of teaching music and by means of the device illustrated, combines, translates, reduces and simplifies the six separate processes indicated by notation—the sign language of music as indicated on the printed page—into one easily understandable picture, thus coordinating the three senses of sight, hearing and touch. This device leads the beginner at once into the joy and beauty of music. Thus acquired, the immediate ability to play thrills the beginner with the joy of his own accomplishment. The value of this system as a developer of concentration has been recognized by many of the leading educators of the world. Anything which will take the drudgery out of learning to play, is certainly a great boon.



All Illustrations by the Author

This is a perspective view, supposedly taken from a park looking towards a street intersection in a part of the city where the plan proposed in the following article has been carried out. Here is seen the automobile runway on the axis of the avenue, the ele-

Buildings of the type which would naturally result from the single offset are also indicated. The ugly effects produced by the present building regulations are gone, and in their places are beautifully designed buildings. Even the finely tapering towers do not de-

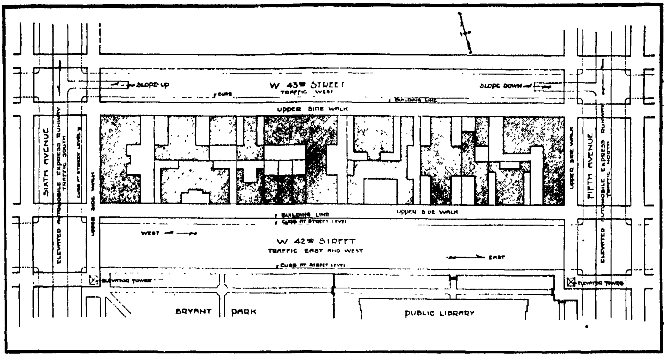


FIGURE 2

In this plan a city block 200 by 900 feet is divided into a number of typical plots on which the buildings are arranged in accordance with the proposed restrictions of area. The plan is supposed to be taken above the elevated sidewalks, and it should be remembered that below them there would be two stories in the buildings, for the outer edge of the sidewalks is on the property line and the inner edge at the offset line. Within the offset line on each plot, one third of the area is shown as vacant, but the proposed regulations provide that light areas are obligatory only above the fourth story of buildings

The City of the Future—II

Revision of Building Regulations Would Increase Greatly the Utility of Large Buildings

By ERNEST FLAGG

IN the last article it was explained how traffic facilities might be increased three-fold, which is evidently necessary if cities are to be three times their former height or bulk.

Many imaginary plans have been made for cities of the future. It is easy to do that, but not easy to make a plan that is practicable. In order to do so there are many elements to be considered. Traffic, light, zoning and the consequent restrictions on height and bulk of buildings are factors so interdependent that all must be taken together in any practicable plan. The one here presented deals with all these things, yet it is so simple that it may be stated in a few paragraphs. Here it is:

Regulations for Height and Bulk of Buildings and Zoning for Use

First: Buildings restricted at building line and for 25 feet back therefrom to a height of two stories. One third of the rest of the plot to four stories and the remainder unrestricted as to height.

Second: Buildings over four stories high in any part thereof not to contain in their construction more wood than an average of one foot board measure to each two square feet of floor space.

Third: No room to be used for dwelling purposes in which a line drawn from the floor through the window at right angles to the wall to the clear sky falls on the floor at less than one tenth of the depth of the room from said wall. Also except at street fronts said line not to cross the line of the plot at a height of less than 50 feet above the street curb.

Fourth: Amended definitions: A tenement house is one in which three or more families cook on the premises and which has no passenger elevator service to every apartment above the ground floor. An apartment house is one in which three or more familes cook on the premises and in which there is passenger elevator service to every apartment above the ground floor. A tarry house is any building over four stories high, used as a club, hotel, lodging, boarding or bath house.

Fifth: The present zoning map to be sub-divided into a great number of small sub-districts, the dividing lines to run where possible through the center of blocks so that both sides of street may have similar treatment, and these subdivisions classified in accordance with the new definitions. Tenement houses, apartment houses and tarry houses to be permitted in all districts except those reserved for dwelling houses, but clubs, boarding, lodging and bath houses not over four stories high may be in any district.

Sixth: A change of designation to be granted when 60 percent of the owners representing 80 percent of the assessed value of the land in any sub-district petition for it.

This is all there is and all that is necessary. Unnecessary restrictions on property and liberty should not be tolerated.

THIS plan would correct a present flagrant injustice in taxation. As matters now stand, if a person owns a building of moderate height in the neighborhood of high buildings, the assessed value of the land is influenced by the earning power of the other buildings. Therefore, unless the owner

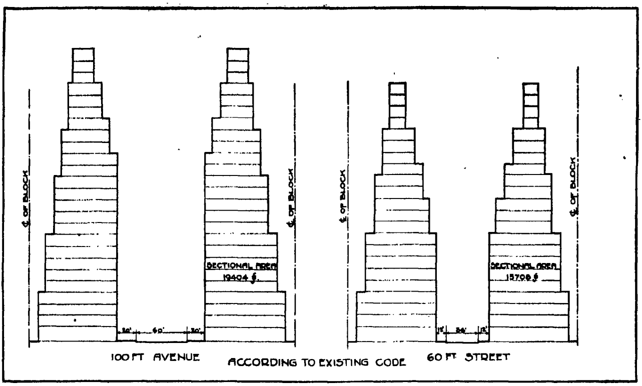


FIGURE 3

Here are represented cross sections through buildings as governed by the present New York regulations; at the left through an avenue or street 100 feet wide and to the right through a street 60 feet wide. In practice, these offsets tend to produce buildings of excessive ugliness as is now quite evident to all

builds to a great height and adds to the general congestion, he is likely to see the whole income from his property virtually confiscated by the city in taxes. By the proposed plan, this would be automatically corrected, especially as regards small plots. If the city limits the area which can be built upon in such a way as to prevent building, or to make high buildings unprofitable, that fact must be considered in assessing land value. If the tax is so reduced that the property can earn a fair return on its value, what has the owner to complain of?

Zoning for use would be by far the easiest part of the problem, provided common sense were allowed to operate. At present the matter is complicated beyond belief. In New York it occupies the larger part of the time of the Board of Estimate and Apportionment and otherwise causes more trouble and friction than any other part of the civic machinery. City officials and others acquainted with its working say it leads to constant irritation, injustice, complaint and trouble.

Zoning for use has for its object the establishment of a reasonable degree of permanency in the various neighborhoods. It is done for the benefit of those neighborhoods, and there should be no desire to continue regulations after they have become distasteful to the great majority in whose interests they were made.

The present classification in New York is very defective in that it places single-family houses, tall apartment houses, hotels, et cetera, all in one category, whereas buildings of these different types often hurt each other when in juxtaposition. The proposed plan therefore provides for four definitions instead of two as at present. If zoning were placed on this basis it would work automatically, and districts improperly zoned at present would soon correct themselves.

We have now sketched in outline the whole plan, but no plan is worth consideration unless it can be shown to be practicable. Any plan of so far-reaching a nature as this is only practicable when backed by public opinion. The public must be convinced of the necessity for it.

LET us briefly consider the three classes of objections likely to be made to this or any other plan having similar objects:

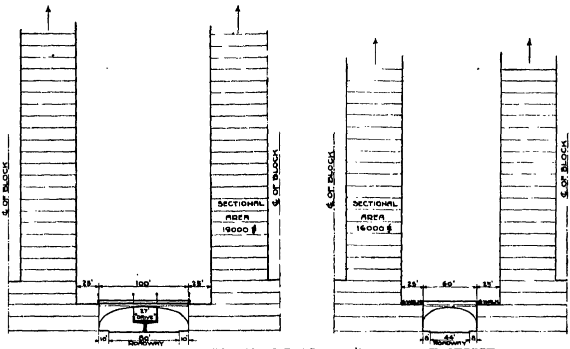
First: Financial difficulties. The cost would be great, but the same objection would apply to any plan and probably not more so to this than to another of even less efficiency. For instance, if it was proposed to triple the width of the streets, the cost would be too great for even a moment's consideration.

Some of the most important parts of the plan can be carried out at little or no cost. The city now has the power to make offsets in buildings and if at one height why not at another? It also has power to establish new building lines. In requiring an offset at the top of the second story it would accomplish what would otherwise be the most costly part of the plan, at no expense whatever, that is, the widening of the streets. Moreover the property holder in most cases would not go unrewarded, for by the increased street width he would obtain much better light for his building and by the elevated sidewalk, greatly increased value of the floor at its level.

Figure 1 shows the type of building which would naturally result from the proposed regulations. It also shows stores at the upper sidewalk level. At present, the required offsets represent nothing but loss and ugliness, whereas offsets of the kind proposed would represent beauty and profit.

Figure 2 shows how buildings might be arranged on a typical New York block of 200 by 900 feet under the proposed regulations. The plots are also typical of those usually found in New York as to size and shape. An offset 25 feet wide has been taken off on all sides of the block above the second story to provide elevated sidewalks. Below this level, floors extend to the present building line. Back of the offset the high parts of the buildings, cross-hatched on the drawing, occupy two-thirds of what remains of the plot, the rest being limited to four stories, the proper lighting of which could safely be left to owners. It will be seen from this that those parts of buildings not directly lighted from the street could for the most part be lighted from courts or recesses from the street.

Figure 3 shows the present New



100 FT AVENUE ACCORDING TO MR FLAGG'S RECOMMENDATION 60 FT STREET

d adds vastly to the value of

the street for light, allows of the necessary separation of pedestrian traffic, and affords another floor for shops, yet the bulk of buildings is not reduced

York regulations as to offsets in principal business districts, for avenues one hundred feet wide and streets sixty feet wide. The result of these offsets is buildings often of excruciating ugliness.

Figure 4 illustrates the single offset under the proposed plan. As both Figures 2 and 3 represent sections of buildings supposed to be of the full width of the plot, the area of the section as indicated on the drawings is proportionate to the area of the floors, from which it appears that no diminution is intended. Moreover, as the height is unlimited under the proposed plan and is limited under the present plan, more floor area may be had if wanted. It is proposed to let economic considerations limit height.

Second: Legal difficulties: Here again similar difficulties would be met in carrying out any plan and perhaps not as much in this one as in another. It would clash with the building and tenement laws and maybe with others, but if wanted by the public, these obstacles could be overcome. If under this proposed plan construction can proceed on the present scale, which otherwise must soon cease, it is not likely that any existing laws can prevail against it. They could be amended or repealed.

Third: Sentimental Objections: To overcome these for any plan will require a campaign of education. People must be convinced both of the practicability and desirability of the plan and that their fears are groundless. For instance, many will object to the elevated runways; they will say we have tried elevated roads and want no more of them—they ruin streets.

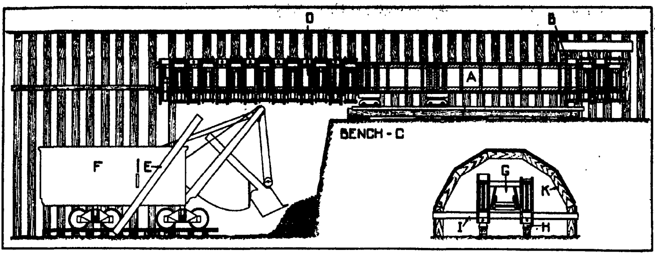
It is not however the elevated railways which are so objectionable, but their supports. Two rows of posts spoil a street but a single row on the axis of the roadway would do no harm. Other similar objections will disappear when the truth is understood. Many will think that the plan will take too long to carry out, but a similar objection would apply equally to any other plan. A hundred years in the life of a city is perhaps not as much as a single year in the life of an individual. Time, therefore, need not be much considered.

ONE great advantage of this plan is that it could be carried out gradually. Section after section could be added as building proceeds and as time passed, the way would always become easier because all new buildings would be prepared to receive it. The greatest difficulties would be in the old buildings which would have to adapt themselves to the elevated sidewalks. To rearrange cities is an operation requiring patience, though when once begun change often takes place faster than would seem possible.

Many years ago when a pupil at the *Ecole des Beaux Arts* in Paris, I worked in a studio in an interesting old building on the *rue du Four,* or street of the oven. The roadway of this street was hardly more than sufficient for two vehicles to pass and the sidewalks in general were very narrow, although here and there a house set back a considerable distance from the curb. On asking the reason for this, I was told that about 100 years before, new lines had been established for the street and everyone who built since had been obliged to conform to them. Moreover, that it was forbidden to make repairs in the old buildings beyond a certain percentage of their value. When I visited Paris two or three years ago, I set out to revisit my old haunts. Upon reaching the place where the *rue du Four* ought to have been, I saw nothing that resembled it. In its stead was a broad modern street with fine shops. I could not believe I was in the right place until I read the name at the corner. Such is the result of that kind of forethought which has made Paris what it is and which if applied here can make New York what it should be.

One thing is certain. We are not proceeding in the right direction now and the further we go from it the harder it will be to retrace our steps. Although the plan here outlined has been described with special reference to New York, its principles are equally adaptable to any other city.

The first one to adopt it would be pre-eminent as the first truly modern city—the one in which changed conditions brought about by steel-frame buildings, elevators and automobiles, have been faced and adequately dealt with, both for the present and future.



MASSIVE, TIME-SAVING, CANTILEVER BEAM

Cantilever rests on trucks, running on a track on the floor of the bench (the upper half of the excavation). A belt conveyor within the beam carries the spoil back to the "muck" cars. The cantilever also supports roof timbers until wall plumb posts are set in place

Speeding Up The Moffat Tunnel

New Cantilever Beam Cuts Time in Half, Saves Labor Costs, and Prevents Disastrous Slides

THE driving of Moffat Tunnel, which is over six miles in length, through James Peak in Colorado, takes rank among the major tunnel operations of the present day. Apart from its size, the tunnel carries a special interest not only for the reason that its methods of construction embody the experience which has been gained in previous work of this character, but because use was made of an entirely new method of excavation, which was developed to meet the difficult conditions which confronted the engineers—difficulties due to the uncertain character of the material and the tendency of the side walls to move in on the tunnel during construction.

In driving tunnels of large size, the upper portion is excavated first, and then the lower half, known as the "bench," is removed. Both operations are carried on simultaneously, the face of the upper section being always a certain distance ahead of the face of the bench. As the upper half is taken out, it is timbered—this timber being supported upon the bench below. Then as the bench is taken out, plumb posts are put in place reaching from the longitudinal wall plate upon which the roof timbers rest, down to the floor of the tunnel.

TO meet the need of quicker and cheaper bench excavation in soft ground, as well as to provide a means of holding the wall plates and ribs in their original position during the operations of excavating the bench and placing the plumb posts in place, a problem frequently confronting the tunnel engineer, George Lewis, General Manager for the Moffat Tunnel Commission, designed a new device which operated successfully at a great saving both in time and costs at the western end of the tunnel.

In driving the tunnel, a method similar to what is known as the "twin headings" was used. The main 16-foot by 24-foot railroad tunnel was paralleled by an eight-foot by eight-foot water tunnel, located 75 feet south of the main tunnel. This latter tunnel served the purpose of carrying water under the Continental Divide from the western to the eastern mountain slope.

TUNNEL WORKING FORCE

Heavy inflows of water during the driving of the tunnel made oilskins necessary

The water tunnel was excavated more rapidly than the main headings of the railroad tunnel, and at convenient distances, usually 1500 feet, cross-cuts were driven from the water tunnel to the line of the railroad tunnel, thus furnishing many points of attack for driving in both directions along the line of the main tunnel. At the west portal, the main headings were driven approximately eight feet by ten feet in section. The top of these headings coincides with the line of the top of the railroad tunnel. This operation was followed by widening to the full width required for the railroad tunnel; after which the wall plates, ribs and laggings were placed. The ribs were thoroughly blocked up at each joint, and all open spaces between the lagging and the surrounding rock were filled with either rock or cord-wood packing. After this work was completed, there remained to be excavated a bench 16 feet in height.

THE predominating rocks are schists and gneisses. The constituent minerals are largely biotite, talc and chlorite. All of these are soft and structurally weak. The formation is broken by faults and fractures—many of the strata being liable to slip when excavation is being carried on. Where this rock is saturated with water, it frequently runs so freely that hay, et cetera is required to check its flow.

Prior to the installation of the Lewis cantilever beam, two different methods were used in supporting the wall plates

and the roof during excavation of the bench below. The first was by the use of rakers or inclined temporary posts, reaching from the wall plates to the top of the bench. These were removed as soon as the long permanent posts of the finished tunnel were set. This method however, interfered with the removal of the excavated material; moreover, it failed to hold the wall plates in place.

Then what is known as the "I"-beam system was tried. This consisted of "I"-beams held up by longitudinal girders, which themselves were supported at one end by cross-members bearing on the wall plates of the completed timbering, the other ends resting on the unexcavated bench. This method also failed to hold the wall plates and roof in position and it proved to be clumsy in operation. Neither of the two methods gave satisfaction. The work was cumbersome, slow and costly, and the wall plates and roof would at times settle until they came within the finished dimensions of the tunnel. Furthermore, in places, the bench was so soft it had to be taken out in two eight-foot sections; a slow and unsatisfactory process.

THE cantilever beam was designed by Mr. Lewis to overcome the objections present in the systems above mentioned, and to speed up the work. The device consists essentially of two parallel plate girders, three and one-half feet deep, 60 feet long, spaced six feet apart and tied together with the necessary cross frames and bracing. The girder is carried on two pairs of "dollies," or trucks, with ball-and-socket bearings to permit free movement in guiding the girders. The girder trucks roll on a 15-inch "I"-beam track laid on 12-inch by 12-inch stringers. At the rear or overhanging end of the beam and extending horizontally at right angles to it, arms provided with a positive horizontal and vertical movement are suspended as shown in the drawings on the opposite page.

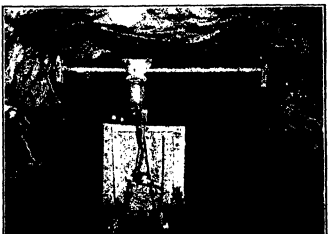
REAR OF CANTILEVER BEAM

This shows shovel taking out the bench. Above is seen rear end of cantilever

In operation, the cantilever girder is supported on the "I"-beam track which is laid on the top of the bench in the completed top section of the tunnel. At its forward end, the girder is prevented from rising by means of "I" beams and powerful hydraulic jacks which extend from the roof timbers down to the top of the girder. The transverse arms are rolled out under the wall plates from the rear end of the girder and are blocked horizontally—thus preventing the wall plates from moving in under the pressure of the rock. The entire arm is then raised vertically by means of a special steel wedge, which is operated by a rod with a right-and-left-hand thread, until the weight of the wall plates and roof timbers is transferred through the cross girders to the cantilever beam. The bench is then drilled and "shot," the broken rock being removed by a one-yard shovel operated by compressed air, which works under the overhanging end of the cantilever beam as shown in our illustration. The plumb posts are then raised into place by a compressed-air hoist.

The speeding up of the work due to this device was remarkable. Under the old "I"-beam system, it was not considered safe to remove more than six feet of bench at one operation, but by the use of the cantilever beam, 17 feet were "shot" and the mucking operations were carried on with ease and speed. Thus, in one cycle of operations, a section of bench 17 feet in length was removed and the permanent plumb posts set in place. The cantilever beam was then pulled forward on its track by the use of another air hoist mounted on the forward end of the machine. The time required for one cycle of operations was reduced from 24 to 18 hours and less as the work gang gained experience. It is estimated that by the time the tunnel is completed, this device will have saved the Tunnel Commission over 2,500,000 dollars in labor costs alone.

THE vastness of the project can be comprehended when it is considered that the estimates place the total rock excavation at 522,500 cubic yards. To excavate and handle this great volume of material, men working in eight-hour shifts are on the job day and night. Electricity for lighting and power purposes is generated at a station on South Boulder Creek. Direct current at 250 volts is supplied for driving the mucking machines, electric locomotives, blowers, et cetera. The air for the compressors is delivered to the headings by means of an eight-inch line that is carried through the water tunnel. Thence, smaller piping conveys the compressed air through the crosscuts to the points where it is required. Since fresh air is essential for the men working at this altitude, a ventilating plant was set up at each portal, capable of delivering about 25,000 feet of fresh air per minute to the various headings.



ONE OF THE MUCK CARS

Air hoist, running on transverse bar, lifts muck cars and transfers them to and from the tracks. This proved a time-saver

THE EXCAVATED TUNNEL

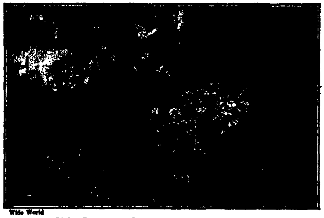
This view shows part of the excavated tunnel where it solid granite. Note the two tracks and the muck

From the Scrap-book of Science—

Wide World

WHERE YOUR USED CAR GOES

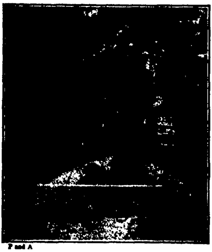
Here is one corner of a used-car bone-yard in Los Angeles. Scrapping worn out and wrecked cars has become an important industry. Everything is classified and practically nothing is wasted. Many parts are used again



Wide World

HORSE SHOES ARE ALSO SCRAPPED

Until quite recently the horse maintained its numbers despite the motor car. Now, however, the horse is decreasing in numbers. Here is a junk pile consisting chiefly of horse shoes, good, now, only for "muck iron"



P and A

TRACTOR MAKES FIREBREAKS

In California, tractor drawn equipment of this kind is used for making firebreaks in the brush. It does much more work than a plow will do

ANCIENT SCIENTISTS COLLECTED FOSSIL

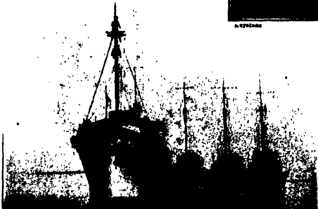
Dr. Barnum Brown, Associate Curator of fossil vertebrates in the American Museum of Natural History, holding in his hands the fossil elephant's molar shown at the right —a most odd and peculiar discovery

Keystone

Keystone

ODD FOSSIL FIND

Tooth of extinct elephant found in ruins of ancient Greek medical school. Did Greeks collect fossils?



P and A

REPAIR VESSEL A "FLOATING NAVY YARD"

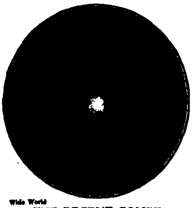
The United States naval repair steamer *Medusa* carries in her hold more than a million dollars worth of stores, ranging from material for overhauling a 12,000 horsepower turbine, down to jewels for ship's chronometers. Most of her crew of over 500 are trained craftsmen. In the picture three destroyers are shown undergoing repairs nearby

International News Reel

PHOTOELECTRIC CELL BURGLAR ALARM

Dr. Robert L. Burt of the California Institute of Technology, has devised a burglar alarm that is actuated by a light-sensitive photoelectric cell. When the intruder interrupts a beam of light, the cell operates a relay, giving an alarm. Thus an intangible bar of light excludes as surely as a bar of steel. The beam is reflected by mirrors

Camera Shots of Scientific Events



Wide World

THE RECENT COMET

The Pons-Winnecke comet. The telescope was moved with the comet, hence the star-trails that show here

Prof. John H. Pitman of Swarthmore College with an astronomical camera with which our recent interplanetary visitor, the Pons-Winnecke comet, was photographed, as shown in the illustration at left. An astronomical photograph is made by inserting a photographic plate in the focal plane of a telescope, in place of the eye, the telescope being slowly moved by a large clock to offset the rotation of the earth ➤

Wide World

Wide World

ORIGINAL "ASBESTOS CAT"

Tex Thornton, clad in an inch-thick suit of asbestos, successfully puts out oil-well fires by exploding T. N. T.

Wide World

PULVERIZED COAL FOR MARINE BOILERS

The development of fuel technology has now reached the point where pulverized coal, for several years used in boiler installations on land, is being experimented with on steamships. Photograph shows tests being made at Philadelphia Navy Yard. Greater fuel economy and numerous other advantages will be gained when it is proved practicable to use pulverized fuel on ships

CHARTING BED OF NEW YORK HARBOR

Photograph shows expert leadsmen making systematic soundings from United States Army Engineer Corps barge in New York harbor. The soundings are recorded by a dictophone which is shown in use at the right

TO CARRY 50,190,000 POUND THRUST

Two of the main bearings of the great bridge that is about to be thrown across Sydney Harbor in Australia. Each enormous bearing will take a 25,000 ton thrust from the foot of the tremendous steel arch butted against it

Outward Bound on the "Ile de France"

This new example of marine architecture is indeed a masterpiece, and we are only able to show a few of the interesting features, especially those reserved for the young people. The *Ile de France* is the world's sixth largest vessel, being of 43,500 gross tons, 790 feet in length, and 98½ feet beam. The turbines develop 52,000 horsepower and drive the vessel at 23½ knots per hour. Among the interesting features of this great boat is the enormous top deck, which can be used for games of all kinds, including tennis. This is shown in the center illustration, marked C. The grand foyer is four decks high. The features which we have elected to show are largely the accommodations for children, which are often sadly lacking on ocean steamers. Not so on the *Ile de France*, where the youngsters have a beautiful little dining room of their own, shown in illustration A, with tables and chairs regulated to their size. There is also a gymnasium, including a merry-go-round, shown in photograph B, and a shooting gallery. There is a charming little Punch and Judy theatre, illustrated at D. Those who are religiously inclined, children and grown-ups alike, can go into the chapel, illustrated in E, at any time, where they will find quiet and reverent surroundings for meditation and prayer. The various public rooms are decorated in the most beautiful manner, and the entire vessel is the last word in luxury for trans-ocean travelers.

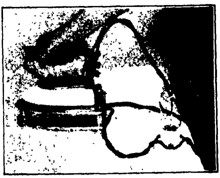
Household Inventions

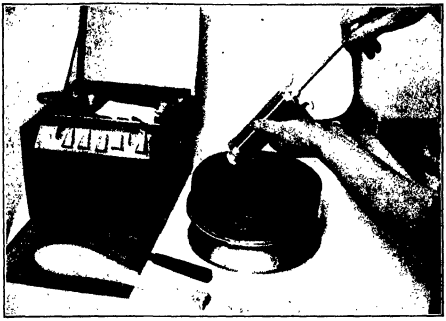
A Department Devoted to Housekeeping Advances

CONDUCTED BY ALBERT A. HOPKINS

SAFEGUARDING THE ELECTRIC IRON

With the electric-iron holders shown above and below, the fire hazard is greatly minimized. In fact we might almost say that all danger is eliminated, for the stands turn the current on or off according to the degree of heat required to supply the iron with the proper ironing temperature. An electric lamp is introduced into the circuit in one make so as to indicate when the current is on or off. The electric-iron is one of greatest aids to the elimination of drudgery and it is gratifying to see the inventors trying to make it absolutely safe by means of such devices as these





TURNTABLE FOR CAKE

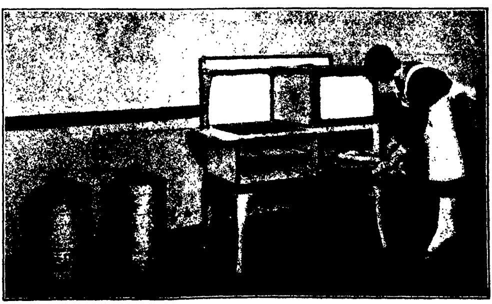
There has always been more or less trouble in turning a cake around when applying decoration. One outfit as illustrated above supplies a turntable made by mounting a pie plate on a deep-dish plate. The decorating accessories are shown, including the palatte knife and wooden paddle. The turntable goes in the bottom of the box

ELECTRICITY POPS CORN

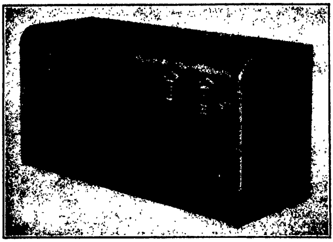
A convenient corn popper that uses electricity for its work is shown at the right. A small crank shown at the left operates an agitator to keep all of the popcorn in motion while it is being popped

COOKING WITH BOTTLED FUMES FROM OIL WELLS

The vapor that rises from oil wells that are in production and even from wells that have been pumped out is now being bottled and sold as fuel. This vapor is refined and compressed until it becomes a low-pressure liquid, which on being released reassumes its gaseous form and burns in an ordinary gas jet. Casinghead gas is a very rich natural gas. As it is compressed, it is refined and the liquid stored in steel bottles. These bottles are attached to heating appliances by means of pipes or tubes and when the valve of the jet is turned, the pressure of the gas forces it through an air mixer similar to that of any gas range. It burns with an odorless flame

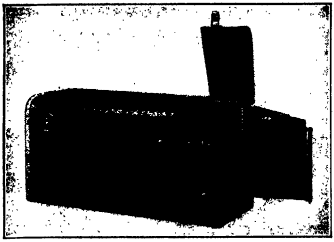


Inventions New and Interesting



AUTOMOBILE TRUNK AND TOOL KIT

The handy automobile accessory illustrated above is completely water and dust-proof, and is extremely strong



THE TOOL KIT OPEN

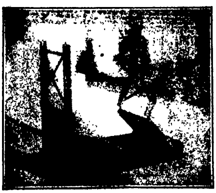
In one end of the trunk is space for tools. In the other end, baggage and other traveling necessities can be carried

WOOD-PILING TRUCK

To reduce the time required for loading and unloading lumber trucks, the body illustrated has been designed. The level-rising platform can be elevated to an extreme height of 11½ feet

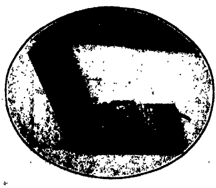
CONVENIENT ROAD MAP

The motorist often has trouble in keeping a road map where it will be readily available for reference. The type shown above will overcome all troubles of this kind. The map is on a roller, and can be rolled up, completely out of the way. An added feature is that the entire device can be attached to any windshield by means of two small rubber suction cups. These afford a firm grip yet the map can be removed at any time when it is desired to substitute another map



TYPEWRITER TABLE

This folding table is also a carrying case for a portable typewriter. Here the table is shown with sides partly folded



READY TO GO

The legs of the table have disappeared within the sides, and the typewriter rests in the space provided for it. Clamps hold the case firmly together

IN WORKING POSITION

The table is held rigid with special braces. There is even a small shelf at one of the sides for papers and the like

The Scientific American Digest

A Review of the Newest Developments in Science, Industry and Engineering

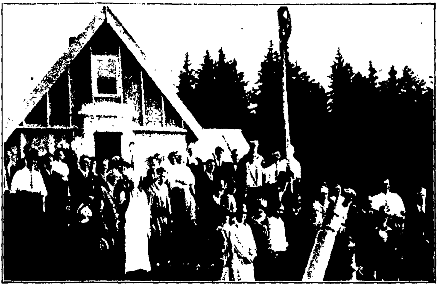
CONDUCTED BY ALBERT G. INGALLS

ısiasts

WHAT a hobby it must be that will drive forty men to travel hundreds of miles to a common gathering place, just to spend two days and all of one night talking about it! That the SCIENTIFIC AMERICAN'S amateur telescope making campaign, begun 18 months ago, is not losing vigor was clearly demonstrated recently when that number of amateurs traveled from several of the eastern states to meet at "Stellafane," Springfield, Vermont, the Mecca of the telescope makers, in order to be present at the second annual convention of this exalted order of astronomical enthusiasts.

"A hobby eminently satisfying and satisfactory," seems to be the verdict after a year and a half of trial of amateur telescope making. "It gets to be almost a disease," some confess; while one man writes that "it has all but ruined my business"—he says he has been unable to lay aside this fascinating work long enough to make a living! We regret that we should have hurt anyone's business by keeping his mind on a hobby, but we confess that there has been quite a little fun and satisfaction in giving such a hobby to 2000 people.

Telescope makers from one end of the country to another, and from Alaska to South America, Japan to South Africa, write us enthusiastic letters, inquiries, requests for advice and assistance and send us photographs of the telescopes they have made. And within the past year or so, hundreds of our readers, working from the SCIENTIFIC AMERICAN instruction book, "Amateur Telescope Making," have completed their reflecting telescopes. A number have already made a second telescope, a few have reached their third, while one—possibly the king enthusiast of all, a Toronto real estate broker—has made four and is still at it with fanatic devotion.



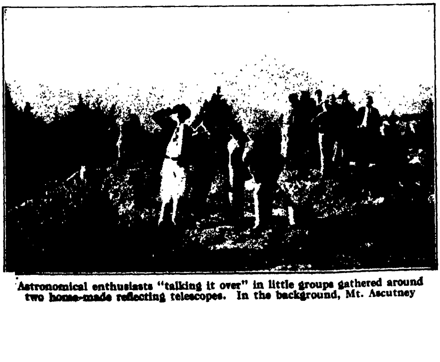
Amateur telescope makers came to Vermont from far and wide. Some brought their families and camped out on the mountain near "Stellafane," which shows in the background. Not a few lady astronomers were present

The man who has not acquired some sort of hobby by the time he is ready to retire from active work should possibly take gas. The best hobby is the one you like the best, no matter what the other fellow thinks about it. A hobby is not supposed to "pay," and must not be justified in any similar way—it just "is." Once he has contracted the telescope "bug," an amateur telescope maker will spend hours and hours pottering in his shop, doing things that admittedly do not pay.

For those of our readers who were not "in" on the first round of our amateur telescope making campaign, a little sketch of this interesting movement might not prove amiss. Two years or so ago one of our sub-editors became interested in this work and soon found that a group of men in Springfield, Vermont, had already made a hobby of it, forming there a club known as "The Telescope Makers of Springfield." With the help of Mr. Russell W. Porter, leader of that group, a "passable" telescope was completed.

"Why not introduce the readers of the SCIENTIFIC AMERICAN to this interesting work?" This thought became uppermost and was presented to the editor for action. This being decided on, an instruction book was prepared, no suitable book being then available. The price of the book was purposely kept down to two dollars because it was realized that many would not wish to spend a great deal of money on the new hobby. The first printing of "Amateur Telescope Making" has now been pretty well disposed of, indicating that the hobby has taken strong hold on our readers who, as we correctly surmised, wish to do some kind of dignified amateur scientific work having real educational value and perhaps requiring more patience and intelligence than the elementary constructional work sometimes described in mechanical journals.

If a man is reasonably handy with his hands—say, if he can tinker his own car or make a fairly respectable radio set—and can scare up about 30 dollars for materials, he can expect to make a reflecting telescope capable of magnifying 50 to 100 diameters. Such an instrument is not a toy, and even if sometimes crude in external appearance—a thing which does not matter if the essential qualities are present—it will still make visible the rings of Saturn, the belts of Jupiter and four of its satellites, the crescent phases of Venus and no end of double stars and nebulae. This is just what those who came to the second



Astronomical enthusiasts "talking it over" in little groups gathered around two home-made reflecting telescopes. In the background, Mt. Ascutney

Finding the planet Venus in mid-afternoon of a dazzling, sunny day. Although difficult to find, and easy to lose again, when seen it is striking

annual convention of amateur telescope enthusiasts at Stellafane, Springfield, Vermont, have already done.

A gathering of this sort ordinarily starts off with a bean feast. A pot of beans is placed in a hole in the earth which has previously been occupied by a fire. In the meantime the amateurs are busy making one another's acquaintance and "gamming" about telescope making.

Someone discovered Venus. This was at four o'clock in a bright sunny summer's afternoon, the sun being about 45 degrees away from that planet. There are still many who doubt whether Venus is visible in full daylight. Once it has been located, however, no doubts ever linger. Venus is as sharp and clear as the moon, only far smaller. The difficulty is to find it, for the sensitive spot of the retina of the eye takes in only a small angle. Once Venus is found, it should be tied in with some kind of marker, like two upright sticks, for it may otherwise be lost.

The night at Stellafane was spent in observation and informal discussion. Saturn hove into view in due time, then Jupiter and finally a deep bank of cloud. But the enthusiasts were more interested in talking about telescope making—for the stars they have at home, fellow enthusiasts they do not.

Mr. A. W. Everest of the Pittsfield, Massachusetts, Laboratory of the General Electric Company, contributed the interesting information that he had discovered a new substitute for the pitch surface on which the mirror is polished. Honeycomb foundation as supplied to bee keepers is simply cut out and placed over the glass tool commonly used. It makes quick contact, retains the rouge abrasive and brings about much more rapid polishing than the pitch surface.

Mr. Everest has made six mirrors and helped others finish three more. He brought with him a telescope having a single mounting made of two-by-four scantlings and two small cart wheels—altogether a rough looking outfit. But his mirror proved to be practically perfect and the instant service this unlovely telescope gave showed clearly that it is a high grade mirror which constitutes the real heart of a telescope, and that a much-polished, elaborate mounting does not take the place of good optical work.

It is expected that a third "get-together" of amateurs will be held at the same place next year. The invitations will again be sent out to those whose *names* and addresses are filed in the offices of this magazine, provided they live within reasonable traveling distance of Vermont. And in the meantime the hobby of telescope making will travel a few times more around the world.

The editors have on hand the photographs and descriptions of about six more telescopes made from the SCIENTIFIC AMERICAN instructions. These will be published in turn in the "Editors-Mail" department but it is believed that the majority of instruments that have been made have not yet been photographed.

Record Size Dome Built in America

AMERICAN architects and builders of the twentieth century have gone their ancient brother craftsmen who designed the noble proportions of St. Peter's Cathedral at Rome one step better in the art of dome construction.

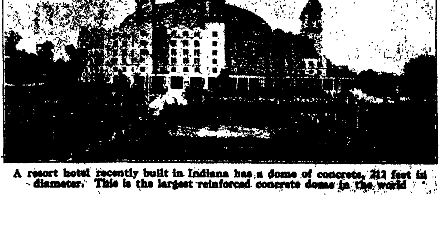
St. Peter's, founded in 1480, is still the world's largest cathedral. However, at West Baden, Indiana, a resort hotel has been built whose immense dome is 212 feet across—12 feet greater than that of the old cathedral, thus making it the largest in the world. A photograph of this structure is reproduced in these columns.

A difficult problem facing the engineers was to design supports of adequate strength to carry the enormous weight of the dome. As completed it rests on 16 solid brick piers laid up in lime mortar. In this respect the new structure is fashioned in the same manner as its ancient rival. The mortar used was a superior modern product but the basic element—lime—was the same as that used by the 15th century masons. This is because of its ability to absorb carbon-dioxide gas from the air and unite with the sand grains and bricks to form a pure limestone and thus bind the masonry into an imperishable mass.

Polarized Light Found to Affect Life

A NEW and hitherto unsuspected influence of the quality of light upon vital processes was announced to the American Chemical Society at its annual meeting held in Richmond, Virginia, by Dr. David I. Macht of the Johns Hopkins University. It is well known that a difference in the wavelength of light, that is, the frequency of vibration, makes a marked difference in its action on plants and animals; that, for instance, rickets may be cured by light of high frequency, such as the ultra-violet rays. Now Dr. Macht has found that the direction of the vibrations also makes a difference in its effects. If the vibrations all lie in the same plane, like a wavy line on a sheet of paper, the action is different than if the vibrations occur in all directions promiscuously as in ordinary light. This peculiar form of light is called "polarized" because the vibrations have a single direction. But it cannot be distinguished by the eye from ordinary light. Ordinary light, such as sunlight, can be polarized by reflecting from a plate of glass or sheet of tin set a certain angle.

An Englishwoman, Miss Elizabeth Semmens, reported in 1923 that polarized light would promote the conversion of starch into sugar. Dr. Macht has confirmed this and gone much farther. Rays of polarized light are found by him to stimulate the growth of yeast and bacteria. Sprouting beans and sunflower seeds grow more rapidly under polarized light than under common light of the same brightness. Certain drugs,



A resort hotel recently built in Indiana has a dome of concrete, 212 feet in diameter. This is the largest reinforced concrete dome in the world

To navigate drifts it is at times necessary to equip the trucks with snow plows, as on the truck in the distance.

such as digitalis, cocaine and quinine, lose in their medicinal power on exposure to polarized light.

Still more interesting is the discovery that polarized light causes sick and poisoned rats to succumb more quickly. Injections of santonin or cocaine caused rats exposed to polarized light to be seized with convulsions, and usually die, sooner than those similarly dosed but living in common light.

These discoveries may aid to explain the irregular and uncertain action of drugs and course of diseases which now perplex the doctors. Daylight is often partially polarized by reflection from sea, snow and sky. Moonlight is largely polarized by the reflection of the sunlight from the surface of our satellite. This may suggest to the reader the possibility that some day science may find some grain of truth in the old folklore theories of the influence of moonlight on plant growth and decay.

—*Science Service.*

A Lazy Man's Method?

SOME people always characterize as a "lazy man's method" any new way of doing a thing which requires less physical exertion than the old method. This, of course, as both parties to the matter well know—although the accusing party never says so—simply means that the onlooker is a little bit envious of the "lazy man's" inventiveness, and permits this envy to take the form of a mild "ragging." Generally, however, the "lazy man's method" is really the intelligent man's method. There is no virtue in working like a mule when a simple subterfuge will as well suffice.

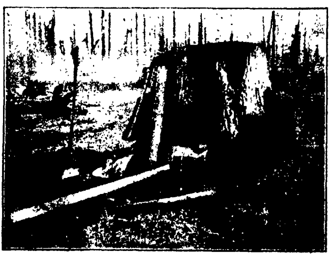
We have seen people making all sorts of exertion to remove stumps, and we have seen easy-going people leave them to rot out only after a lifetime of ploughing around them. With a burner consisting of a cast-iron furnace, two hoods, a long draft pipe, two short draft-pipes and several lengths of ordinary six-inch stove pipe, Mr. S. F. Zysset, an Oregon farmer, recently cleared several acres of large stumps at less than half the cost of the otherwise necessary blasting powder and stump puller. The method employed is a modification of the old "char-pitting" method, sometimes called "coal pitting," which when properly carried out would consume not only the big stump itself but also a large part of the roots below plow depth.

The fire once well started, the furnace is removed from the stump. With a good draft on one side and a smoke stack on the other the stump itself is now a stove. All the little air holes are tightly

Char-pitting was, however, a hard process, and therefore few used it. The new method is so simple that anyone may easily apply it.

As shown in the two illustrations reproduced in these columns, a simple furnace with pipes is inserted in the stump. After the fire is going well, the furnace is withdrawn and the stump is chinked up with earth so that it really constitutes the shell of a furnace itself. The charring process continues for several days until the roots are burned out. This equipment is best used on stumps more than two feet in diameter. The larger the stump the better it burns, once it is well started and supplied with a draft and chimney.

One might indulge in an apostrophe of the burning stump shown in one of our illustrations, somewhat as follows: "Old stump, you're mighty big, and mighty strong and stubborn. I could pull you out with perhaps 100,000 pounds of force; or I could dig you out in a week of hard work. But I'm not one of those chaps who think a man is earning his way only when he's as busy as a frantic dog digging out a rabbit hole. So I'm just going to stand around here, leaning on my shovel and smokin' my old pipe while you burn out. And then next month I'll plant potatoes where you, with all your strength, thought you were safe forever. Old stump, you can't stump me."



The stump burner's equipment, simple and portable. At the right is the furnace, at left is the extra hood and nearer by are some lengths of iron pipe to be used for placing the draft precisely where it is needed

Seeks Large-Fruited Native Apple Trees

WANTED: Native American crab-apple trees that bear large apples. Prof. N. E. Hansen of South Dakota State College, Brookings, South Dakota, is on the lookout for American crabapple trees that can not only make the prairie groves and forest edges glorious with pink bloom in the spring, but later on yield fruits fit to eat, which few of them do now. Or, if they will not bear good apples by their unaided selves, Prof. Hansen proposes to cross them with desirable varieties of the European and Asiatic stocks already in cultivation, and thus obtain hybrids good for planting in the cold and semi-arid plains and foothills of the northwest. Get in touch with him if you know of any wild trees of the native species whose fruits might be worth while in his program.

—*Science Service.*

Will Powdered Coal Challenge Diesel Oil-Engines?

BEFORE long, many sea-going ships are likely to burn pulverized coal for fuel, thus meeting the present challenge of the Diesel heavy-oil engine, according to the results of tests described by C. J. Jefferson, head of the Fuel Conservation Committee of the Merchant Fleet Corporation of the United States Shipping Board, in *Marine Engineering and Shipping Age* (New York). Pulverized fuel—coal ground to powder and blown into the firebox of a boiler by means of air forced from a series of nozzles—has already made giant strides on shore, where it is installed in some of the largest power stations in the world. Mr. Ford, among others, uses it at River Rouge, Michigan.

"Why should the use of pulverized fuel on ship board be developed?" asks Mr. Jefferson. "What are the differences between a power plant at sea and one on the shore that requires this development work? These two questions, in brief, cover the problem that was put up to the Fuel Conservation Committee of the Shipping Board about a year ago.

"Why should pulverized fuel be made sea-going? Because when it has learned sea-going ways and learns how to behave itself in a marine plant, it will then effect economies in the operating costs of our existing vessels of such a magnitude that an auditor's statement can be a real pleasure.

"If the boiler efficiencies obtained with oil can be duplicated, and if this duplication can be accomplished in such a way that the operating problem is no greater than that on the oil burner, and if all of this can be done with a fuel

(*Continued on page 368*)

INDUSTRIES FROM ATOMS

A Department Devoted to the Advancements Made in Industrial and Experimental Chemistry

CONDUCTED BY D. H. KILLEFFER

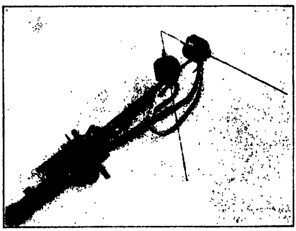
Flames of Atomic Hydrogen

EXPERIMENTS carried out in the laboratory of the General Electric Company by Dr. Irving Langmuir have led to the development of a remarkably efficient welding flame for use in a manner similar to that of oxy-acetylene flames but based instead upon the formation and burning of hydrogen in the atomic state. The passage of ordinary hydrogen gas, made up of molecules, each containing two atoms of hydrogen, through an electric arc appears to break it up partially into free atoms of hydrogen. When these atoms of hydrogen are then burned, the temperature produced is sufficient to melt "every refractory material which has been tried, except carbon . . . with comparative ease." Calcium oxide, melting at 2580 degrees, Centigrade; pure magnesium oxide, melting at 2800 degrees, Centigrade; pure thorium oxide melting above 2890 degrees, Centigrade, and numerous other refractories were melted without difficulty. Temperatures above 3200 degrees, Centigrade, were noted on an optical pyrometer.

In reporting his experiments before a recent meeting of the American Chemical Society, Dr. Langmuir described the commercial form of his welding torch as follows:

"The accompanying figure illustrates one of the later forms of torch used for welding. Two tungsten rods, as electrodes, are held at a definite angle to one another by easily adjustable clamps, and a jet of hydrogen is directed from a small nozzle along each of these rods near its end. The hydrogen thus bathes the heated parts of the electrodes and forms a gentle blast of gas which passes through the arc between the electrodes so that these are not unduly heated. Other torches have been built suitable for automatic welding using machine feed. The electrodes are ordinarily separated three or four millimeters and the arc assumes a fan shape extending six to ten millimeters from the electrodes. Alternating current is generally used.

"The high temperature of this flame, together with its powerful chemical reducing action and the avoidance of gases containing oxygen and nitrogen, renders it particularly useful for welding, not only for iron and its alloys, but for such metals and alloys as contain aluminum, magnesium, chromium, manganese, et cetera."



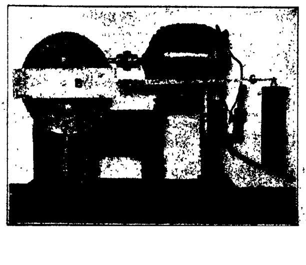
Left: One form of the atomic hydrogen welding torch. In this, the two electrodes, held at a fixed angle, are constantly bathed by a stream of hydrogen emanating from a small nozzle near the end of each of the rods

Samples of metals welded by this means show remarkable ductility. A one sixteenth inch low-carbon steel sheet was welded and then double folded along the line of the weld and double folded a second time at right angles to the first fold without any sign of cracking. A weld in one eighth inch sheet was deeply embossed without any sign of failure. The application of this method to commercial practice seems to offer promise of great value.

Measurement of Tire Life

LONG wearing tires are the goal of all rubber manufacturers, but it is impossible for them to wait until actual service has worn out their tires to find out whether their product is actually good or not. For this reason many mechanical devices for reproducing road conditions are in use, but according to Ira Williams of the Mellon Institute of Industrial Research, none of the machines so far

(*Continued on page 368*)



Right: This rubber-tire testing machine operates on the principle of the Prony brake. In it, the friction surfaces of the brake are lined with pieces of the rubber to be tested. An abrasive wears against the rubber

Learning To Use Our Wings

This Department Will Keep Our Readers Informed of the Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

Ship to Shore

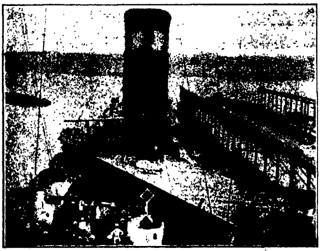
CLARENCE D. CHAMBERLIN, transatlantic flyer, has added to his laurels, by making the first ship to shore flight from the deck of a merchant vessel, the *Leviathan* of the United States Lines.

Above the boat deck of the huge vessel, of nearly 60,000 tons register, a broad runway 114 feet long was built, extending from the starboard side of the first stack, to the port side of the deck above the bridge. To help the process of getting off, the runway was inclined at an angle of three degrees, with a leveled-off portion toward the bow to eliminate a diving tendency after the get-away. At the time of the test, there was a wind of 15 miles an hour, and the *Leviathan* itself was steaming at about the same speed.

Commodore Hartley so maneuvered the *Leviathan* that the wind was practically athwartship. The resultant velocity of the air relative to the vessel was therefore in the direction of the longitudinal axis of the runway, and the magnitude of this resultant velocity was approximately 20 miles per hour. Thus Chamberlin had ideal wind conditions. His Fokker biplane, equipped with a Wright Whirlwind engine, was lightly loaded, carrying only 900 pieces of mail, in addition to the pilot, and some two hours supply of gasoline.

The pilot only had to stick to the runway for a distance of 75 feet, before his speed, plus the relative speed of the wind, sufficed to get him into the air. Chamberlin had admitted that he could "swim about a stroke," but had added with his characteristic quiet smile, "I am going to fly, not swim."

There was a driving rain at the time, and the pilot wore a borrowed rain coat that was somewhat too large and flapped about his legs. The *New York Times* thus graphically describes the beginning of the flight: "The flier played with the controls for a moment, testing his rudder, the ailerons and elevator. Four short blasts came from the *Leviathan's* siren. Then the motor roared and the plane answered. The tail raised to flying position. Chamberlin gave the engine full throttle, pushed his stick forward, jumped his blocks and shot down the runway . . . the plane was off at 75 feet. Instantly the pilot lifted his ship into an almost perpendicular climb to an altitude of 500 feet. As the plane slowed almost to the stalling point, Chamberlin pulled it over in a slow backward turn and straightened out to dive back toward the *Leviathan*. As he swooped down he pulled back his stick and zoomed high over the masts."



Chamberlin's Fokker biplane on the runway specially built on the deck of the *Leviathan* for a test flight from ship to shore. This was made to determine the possibility of speeding up transatlantic mail service by means of a supplementary aerial transport

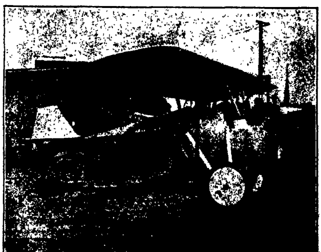
After paying his respects by other startling maneuvers to the *Leviathan* and to the Coast Guard destroyers acting as escorts, Chamberlin covered the distance between a point at sea 80 miles east of the Ambrose Light to Curtiss Field, Garden City on Long Island, in a little over an hour, greeted his friends, and then flew to Teterboro, New Jersey, delivering his mail bag safely to the Postmaster.

Chairman T. V. O'Connor and General Manager David A. Burke of the U. S. Shipping Lines are enthusiastic over the feat, which they characterize as a revolutionary boundary mark in ocean travel. Assistant Postmaster-General Irving W. Glover states that the Post Office Department has under consideration the plan of attaching to each transatlantic liner, an auxiliary airplane. The plane would remain on shore until the vessel was from 24 to 48 hours at sea and then catch it with last minute mail and passengers. The ship would then carry the plane to within an equal distance from the European shore, when the plane would hop off with mail and passengers and beat the vessel to port. With such a service in operation, it is estimated that the transatlantic mail time could be cut to less than 72 hours.

As Chamberlin is the first to admit, however, not all the difficulties in such a plan have been overcome. In this first trial, the loading of the plane was light, and there was a strong wind to be added to the speed of the vessel. With a plane heavily loaded and little wind, even the long platform might prove insufficient for a get-away, yet the platform would be a most unwieldy structure for almost any liner other than the *Leviathan*. Chamberlin himself advocates the use of a catapault as being likely to give safer and more reliable service. He also considers the advisability of adopting forward masts of the arch type. This would enable the plane to take off on a runway that ran directly off the bow, and through the divided mast, thus greatly simplifying the problem of maneuvering the vessel so as to get the resultant wind in line with the runway.

Among other plans discussed is that of using a huge net to be rigged atop ships into which airplanes could drop their mails after overtaking the surface vessel.

(*Continued on page 360*)



The two-cylindered monoplane shown at the right was constructed by W. F. Hopkins and T. Mead, North Island, California, navy men. It has a wing spread of 28 feet and is only 17 feet long overall. It is said to be able to carry the pilot and fuel for two hours flight

Applied Science for the Amateur

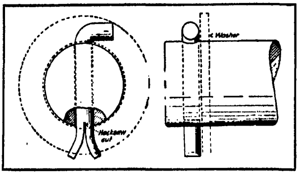
A Department Devoted To the Presentation of Useful Ideas Material of Value To All Will Be Found Here

CONDUCTED BY A. P. PECK

Large Cotter Keys Made from Round Iron Rod

ACCORDING to F. Bentley, writing in *Power*, large cotter keys are seldom handy when one wants them, and frequently rather impractical substitutes are used.

A practical large cotter key up to one-half inch can be quickly made of the body of a bolt or piece of round rod as shown in the illustration. The tail is split with a hack-saw only a little farther than the edge or face of the rod it is spread against. Almost any iron rod will stand a right-angle bend in the vise without fracture to make the head.



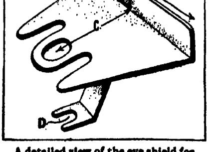
Large cotter keys or pins are often hard to find. Also, they must be strong in order to be of value in most mechanical work. At the left is shown how to make a pin that will be strong in the extreme, and can be made in any size required to fit any particular job

Such a key is much easier to punch out after it rusts in, and it will cover a washer and hold it as well as the standard pressed keys.

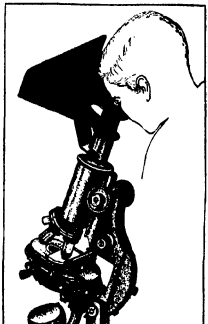
Light Screen for Use on Monocular Microscopes

THE accompanying sketches illustrate a simple device which may easily be attached to any ordinary monocular microscope for the purpose of screening the eyes of the microscopist from slanting rays of light and also from the distracting secondary vision of the "off" eye.

The device may consist of a single sheet of light metal (preferably aluminum) or rigid cardboard, so cut as to fit the eye-piece of the microscope and so notched on either side as to admit the bridge of the nose to such a position that the functioning eye is exactly opposite the center of the ocular lens. By having the screen notched for the nose on both sides, it is possible for the worker to alternate the use of his eyes, thus further reducing the eye strain. The horizontal portion of the screen is calculated to shut off secondary vision as well as interfering light rays, while the vertical portion acts principally in the exclusion of slanting light rays from the worker's eyes.

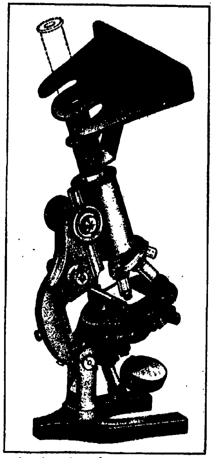


A detailed view of the eye shield for monocular microscopes. It is easy to make from the directions given



The eye shield in use. Notice that it can be used for either eye of observer

This device has been used by the writer for several years, being found particularly advantageous as an aid in prolonged or continuous use of the microscope. It is made of thin, light sheet aluminum shaped after a cardboard pattern that was previously fitted to the worker's physiognomy. The device is coated with dull black paint to prevent the reflection of light as much as possible. A very satisfactory pasteboard screen can readily be improvised in any laboratory with a sheet of pasteboard, a pair of scissors and a small quantity of India ink or dull black paint.



Another view of the light screen. This shows how shield is attached

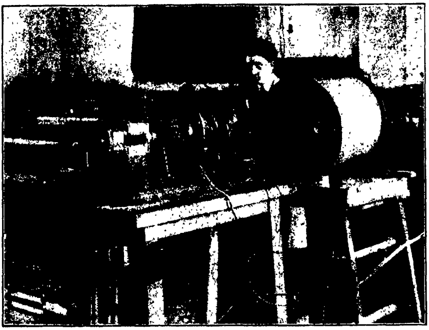
One of our illustrations shows the perspective of the device. The entire width (A) is 14 inches, the height of the perpendicular screen (B) is three inches, and the depth of the horizontal screen (C) is four and one-half inches to the center of the eye piece. A forked brace (D) supports the weight of the shield from beneath.

A second drawing shows the method of attaching the device to the microscope, by first removing the eye piece, inserting the screen, then replacing the eye piece through the eye hole in the screen. The device is also shown in use.—*Contributed by Dr. Hubert Bunyea, Bureau of Animal Industry, United States Department of Agriculture.*

Radio Notes

A Monthly Review of Progress in Wireless Communication

CONDUCTED BY ORRIN E. DUNLAP, Jr.



Belin's photo-radio transmitter based upon the principle of scanning the image to be transmitted with a rapidly moving spot of light. The arc light at the left produces the light beam which is reflected by a pair of oscillating mirrors. These throw the beam across the image and onto the photoelectric cell in the large cylinder. The varying impulses of light actuate the transmitter by means of the current controlled by the photoelectric cell

Prospecting by Radio

THE theory of prospecting by radio is as follows: Ore bodies located in the earth act as good conductors of electricity, and can act as antennas. Sulfide ore bodies are good conductors of electricity, the same as copper-wire antennas. The radio waves create an oscillating current of electricity in ore bodies, the same as in antennas. Any oscillating current will radiate waves of its own. Therefore the ore body in theory may become a miniature radio station, due to the oscillations created in it. This phenomenon is called re-radiation. Ore bodies throughout the world are continually absorbing and re-radiating radio waves sent out by radio stations. The reradiated waves, however, are so feeble that they cannot easily be detected.

Therefore, in prospecting, a specially designed transmitter is set up in the immediate neighborhood to be prospected. The ore body receives strong waves from the near-by transmitting station and therefore reradiates a fairly strong wave. The latter is picked up by a loop receiving outfit located close by.

The loop antenna is rotated around a horizontal and vertical axis and thus it becomes a radio compass. Headphones are connected with the apparatus and as the loop is rotated, the position of maximum and minimum sound is determined and the instrument readings are recorded. The direction and location of the ore body can then be computed from these readings.

In practical prospecting, when there is an indication of an underground conductor, such as an ore body, and it is desired to make the information as definite as possible, a large number of readings are taken at intervals of 25 to 50 feet across the suspected axis of the ore body, and for a distance along the axis as far as it is desired to investigate. These readings are then correlated on paper and cross sections made. The location of the ore body is said to show quite plainly on such cross sections.

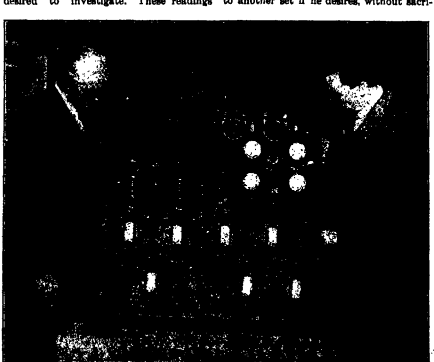
Bright Future Seen for Socket-Power Units

THAT the demand of the radio public is for convenient and dependable operation of the radio set from the light socket without sacrifice of radio quality or performance was the opinion expressed to the manufacturers in convention by Walter E. Holland, research engineer of the Philadelphia Storage Battery Company.

"The listening public is getting more and more critical of performance and will not tolerate distortion or hum," Mr. Holland went on. "Quality must not only be retained but must be improved. Furthermore, the public does not want to be limited to low power or so-called dry-cell tubes.

"So far, economy of operation has not been a major factor in radio. The prospect has bought the best set he could afford, or in many cases, the set his friends talked about, whether or not he could afford it, and has not counted the costs. This is passing. With more and more good sets to choose from, economy will be the deciding factor in many instances.

"It is to the advantage of the customer to purchase standard socket-power equipment that may be used to operate any good radio set. He is then free to choose his set on its merits alone rather than to choose some special set because it is designed for light-socket operation. He is also free to change to another set if he desires, without sacri-



This radio set, built for the St. Giles Hospital, Camberwell, England, is designed to operate 550 pairs of headphones and 42 loudspeakers

Wide World

Engineer in cab of freight locomotive talks by radio with men in caboose

ficing his investment in the power equipment," said Mr. Holland.

"Present radio receivers with standard tubes, socket-powered with the present indirect system of 'A' power and good rectifier-and-filter 'B' power, set a very high standard of performance, convenience and economy. With this high standard established as a criterion, together with the great commercial advantages, it is not likely that alternating-current tubes or other new devices will quickly supplant the present tried-and-true system. The alternating-current tube, no matter how good it may be in its ultimate development and application, can only closely approach or at best, equal present standards of performance. It is not within the bounds of probability that it will attain such perfection without going through a long period of quantity production."

Latest Radio System for Freight Trains

THE practicability of a locomotive engineer sitting in his cab conversing by radiophone with a brakeman in a caboose at the rear end of a freight train one mile long, was recently demonstrated in tests conducted by the General Electric Company and the New York Central Railroad.

The cab and caboose were equipped with the necessary aerials and transmitting and receiving apparatus. Short waves were used in order to avoid interference with the regular broadcasting stations. The engineer shouted that a collision was impending and he ordered the brakeman to throw the emergency valve to stop the train. The command was received in the caboose, the engineer's voice coming through clear and strong.

Radio communication will be valuable on trains made up of from 75 to 125 cars, where the engineer and conductor are separated by a mile of train, according to railroad officials. They point out that heretofore signaling between the extreme ends of long freight trains has been done by whistles or by flare lights, which often fail because of curves in the route or because of inclement weather conditions. Furthermore, if a defect ever developed in a long train the conductor either had to send a brakeman on the dangerous trip along the tops of the cars to inform the engineer, or he had to pull the emergency valve to stop the train. Time can be saved by the radio method.

When radio communication is desired, a signal is given by either the engineer or the man in the caboose pressing a button, which causes a howling noise to attract attention at the other end of the train.

"Dummy" Aerial Used in First Test

A HALF-HOUR before a broadcast period is to be heard from either WEAF or WJZ, the transmitters are placed on a test on a "dummy" antenna, consisting of large banks of electric lamps lighted by radio-frequency energy and providing the equivalent of the actual radiation system. Frequency measurements are then made throughout the entire transmitter, insuring that the apparatus is functioning properly.

When a broadcast period is ready to go on the air, a signal is received at the transmitter from the studio. Immediately, the carrier wave is fed into the antenna, and this fact is in turn signaled back to the studio. In the case of WEAF, this signal is automatic, since the carrier wave energizes a coil which operates a relay in the control room, illuminating a green light on the announcers' control box in the studio.

As a rule two operators compose the watch at the transmitter. One of them occupies himself with the transmitter proper, while the other listens in on the 600-meter ship communication channel so that the station may be shut down immediately in case an SOS signal is heard. While it is a matter of pride that the station be kept continuously on the air, it is equally important that broadcasting be discontinued if a signal of distress is being sent out by a vessel at sea.

Broadcast listeners who have difficulty in separating programs from their local stations will probably be interested to know that at WEAF and WJZ this 600-meter watch is constantly maintained directly beneath the stations' antennas, in spite of the fact that WEAF operates on 491.5 meters, and WJZ on 454.3 meters. So efficient is the receiving equipment that in addition to hearing near-by ships and coastal stations, the 600-meter "watchman" usually listens to vessels in South American and European waters and land stations in these same localities during the course of an evening.

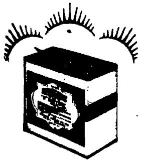
New York Leads

THE ranking of states as radio markets, tabulated from passenger automobile registrations, broadcasting stations, income tax returns and population, shows that New York leads the country with 10.09 percent of the business, having 655,850 sets in use. The closest rival is Pennsylvania with 7.74 percent of business, using 503,100 sets. Illinois comes third with 7.20 percent of business done, having in use 468,000 sets. This is followed by California, with 6.34 percent of business, using 422,100 sets, and Ohio, with 5.59 percent, or 363,350 sets.

The saturation comparison to date is as follows: Number of homes in the United States, 26,800,000; number of phonographs, 11,000,000; number of passenger automobiles, 18,000,000; number of telephones, 17,000,000; number of homes wired for electricity, 15,900,000; number of farms, 6,370,000, and number of homes without radio sets, 20,300,000. The radio saturation totals 24 percent, showing that more than three quarters of the country is still a potential market for radio apparatus, sets and parts, and the farms represent a most fertile market.

A freight locomotive equipped with radio for communication with other end of train. Antenna parallels the boiler on each side

Restored Enchantment



This is the Eveready Layerbilt that gives you Battery Power for the longest time and the least money.

THERE is no doubt of it—radio is better with Battery Power. And never was radio so worthy of the perfection of reception that batteries, and batteries alone, make possible. Today more than ever you need what batteries give—pure DC, Direct Current, electricity that flows smoothly, quietly, noiselessly. When such is the current that operates your receiver, you are unconscious of its mechanism, for you do not hear it humming, buzzing, crackling. The enchantment of the program is complete.

Batteries themselves have improved, as has radio. Today they are so perfect, and so long-lasting, as to be equal to the demands of the modern receiver. Power your set with the Eveready Layerbilt "B" Battery No. 486. This is the battery whose unique, exclusive construction makes it last longer than any other Eveready. Could more be said? In most homes a set of Layerbilts lasts an entire season. This is the battery that brings you Battery Power with all its advantages, conferring benefits and enjoyments that are really tremendous when compared with the small cost and effort involved in replacements at long intervals. For the best in radio, use the Eveready Layerbilt.

EVEREADY
Radio Batteries
—they last longer

Radio is better with Battery Power

At a turn of the dial a radio program comes to you. It is clear. It is true. It is natural. You thank the powers of nature that have once more brought quiet to the distant reaches of the radio-swept air. You are grateful to the broadcasters whose programs were never so enjoyable, so enchanting. You call down blessings upon the authority that has allotted to each station its proper place. And, if you are radio-wise, you will be thankful that you bought a new set of "B" batteries to make the most out of radio's newest and most glorious season.

NATIONAL CARBON CO., INC. UCC New York—San Francisco

Unit of Union Carbide and Carbon Corporation

Tuesday night is Eveready Hour Night—9 P. M., Eastern Standard Time

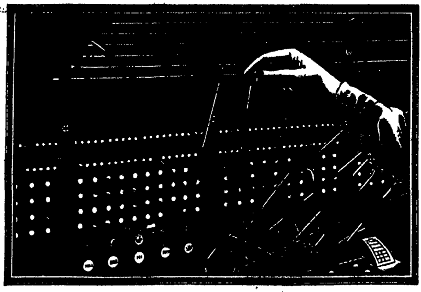
WEAF—*New York*	WGR—*Buffalo*	WGN—*Chicago*	WRC—*Washington*
WJAR—*Providence*	WCAE—*Pittsburgh*	WOC—*Davenport*	WGY—*Schenectady*
WEEI—*Boston*	WSAI—*Cincinnati*	WCCO {*Minneapolis* / *St. Paul*}	WHAS—*Louisville*
WDAF—*Kansas City*	WTAM—*Cleveland*		WSB—*Atlanta*
WFI—*Philadelphia*	WWJ—*Detroit*	KSD—*St. Louis*	WSM—*Nashville*

WMC—*Memphis*

Pacific Coast Stations—9 P. M., Pacific Standard Time

KPO—KGO—*San Francisco*	KFI—*Los Angeles*
KFOA—KOMO—*Seattle*	KGW—*Portland*

Have you heard the new Victor record by the Eveready Hour Group—orchestra and singers—in Middleton's Down South Overture and Dvořák's Goin' Home?



Learning To Use Our Wings

(*Continued from page 352*)

An alternate plan would be to use seaplanes to overtake the liner, land beside her and be picked up later.

Whatever the ultimate method employed, there is no doubt that what is now a startling innovation will ultimately become as much a matter of routine as taking on the pilot.

Safe Aircraft Competition

ACCORDING to Colonel Guidoni, to say that air transport has now attained the safety of other methods of transport is an incorrect statement. It is, according to Colonel Guidoni, sufficient to compare air transport with that by motor vehicles, railways and ships. Last year in the United States, for ten million motor cars there were 15,000 deaths. Allowing 450 running hours per year for every motor vehicle, carrying two persons, there is a death every 300,000 hours or one for every 600,000 passengers. It is to be noted that most of the killed were pedestrians. An English railway company during last year carried over 40 million persons without a single fatality. A motor-bus company carried 600 million passengers with 10 deaths, that is, one death in 60 million passengers. The figure for marine transport is difficult to give as there are no exact statistics, but counting all transport services utilizing water craft, there was not one death in 300,000 passengers. In a continental commercial air service, from 1921 to 1926, there has been one death per one thousand passengers; in another, on the other hand, there was only one death per 55,000 passengers.

Aviation safety is constantly improving. Figures for the last year or so would be much more to the point. Certainly in the United States safety in flying is greater than that shown by the above European air services. Much remains to be done, however.

Aviation safety depends on many things; aerodynamic characteristics; fire prevention; reliability of the power plant; weather; radio and lighting and other aids to aviation; inspection of ships and pilots; ground organization, et cetera. It is hard to say which is the most important. Certainly aerodynamic characteristics need to be improved.

The Daniel Guggenheim Fund for the Promotion of Aeronautics has made the encouragement of safety one of its main objectives, and as its first line of attack it announces the Daniel Guggenheim Safe-Aircraft Competition "to achieve a real advance in the safety of flying through improvement in the aerodynamic characteristics of heavier-than-air craft, without sacrificing the good practical qualities of the present-day aircraft."

To this end the Fund is offering a First Prize of 100,000 dollars, and five "Safety Prizes" of 10,000 dollars each, which will be awarded in accordance with the Competition Rules.

Major Mayo has thus summarized the aerodynamic weaknesses of present day aircraft:

1. The landing speed is far too high and the length of run after landing is too great.

2. The gliding angle is too flat, making the approach to a given spot

for landing too difficult for safety.

3. The length of run before taking off is too great.

4. The angle of ascent after taking off is not great enough.

5. If the airplane is stalled (that is flown at too big an angle to the air stream), it becomes unstable and at the same time control is lost.

The rules of the competition are a derivative of this summary.

The aircraft must have a reliable power plant, good structural characteristics, carry five pounds of useful load per horsepower, and have adequate vision and accomodation. These rules insure that the aircraft satisfies the requirements of good, present-day practice.

Further the aircraft must show good stability, ability to recover from abnormal flight conditions, be perfectly controllable and maneuverable, and particularly be perfectly safe when the engine suddenly fails on a steep climb—a condition frequently followed by a dangerous stall.

Further specific points are awarded on the following tests:

1. Speed Tests.

(a) Two points for every mile per hour less than 35 miles per hour at which level flight can be maintained, up to a maximum of 10 points.

(b) Four points for every mile per hour less than 38 miles per hour which is not exceeded in a steady glide, up to a maximum of 10 points.

(c) One point for every two miles per hour in excess of 100 miles per hour at which level flight can be maintained, up to a maximum of 10 points.

2. Test of Landing Run.

Two points for every three feet less than 100 feet in coming to rest after first touching the ground, up to a maximum of 40 points.

3. Test of Landing in Confined Space.

One point for every two feet less than 300 feet from the base of an obstruction 35 feet high in coming to rest after gliding in over the obstruction, up to a maximum of 75 points.

4. Test of Take-Off.

One point for every 15 feet less than 800 feet required to take off from standing start, up to a maximum of 15 points.

One point for every 10 feet less than 500 feet to clear obstruction 35 feet high from a standing start, up to a maximum of 26 points.

The ideal machine which would achieve the total of 200 points would have the following characteristics: Maximum speed, 180 miles per hour; minimum speed with power, 30 miles per hour; minimum gliding speed, 32 miles per hour; landing run, 40 feet; landing over an obstruction 35 feet high in 150 feet; take-off in 75 feet; clearing an obstruction 35 feet high on take off in 240 feet.

There is not the slightest doubt that such a machine would be wonderfully safe to fly! The Safe Aircraft Competition is likely to produce almost revolutionary improvements in aviation safety.

A One-Wheel Plane

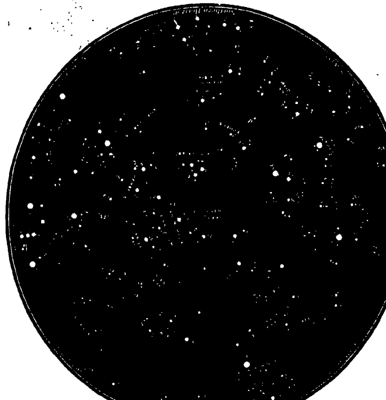
THE manufacturers of the well-known Loening amphibians, which have carried the "good-will" fliers to South America and back, are now producing an amphibian with but a single wheel,

offering obvious advantages in cutting down weight and complexity of the retractible landing gear. The only modification of the general design which seems necessary is that the tip-floats should be provided with long, flexible skids, protecting the wings when the plane rolls to one side or the other on the ground.

We should judge that "taxying" such a plane on the ground would be no harder than riding an ordinary bicycle. At any rate the Army Air Corps, bent on testing the idea, took an old training plane, equipped it with a single central wheel and found that the idea was practical. We have no exact details of the tests. Probably the pilot has to turn toward the side which is for an instant dangerously low; the centrifugal force produced by the turn should quickly right the plane into a normal position. Our Air Corps pilots are so used to "stunts" of every kind, that these acrobatics no doubt provide them with an enjoyable novelty.

The Heavens in October

By PROF. HENRY NORRIS RUSSELL, Ph.D.



11 o'clock: Oct. 7.
10½ o'clock: Oct. 14.
At 10 o'clock: Oct. 22.
At 9¼ o'clock: October 30.
At 9 o'clock: Nov. 7.
At 8½ o'clock: Nov. 16.
At 8 o'clock: Nov. 23.

NIGHT SKY: OCTOBER AND NOVEMBER

The Heavens

OUR map this month shows the principal constellations, the Dipper low in the north, Draco and Ursa Minor above, then Cassiopeia and Cepheus. Cygnus and Lyra are prominent in the northwest and Aquila in the west. The great and almost barren region in the center is brightened by the presence of Jupiter, and by Fornax lower down. Pegasus is higher in the south and Andromeda and Pisces in the east and northeast. Below them are Auriga and Taurus, while Orion and Gemini are rising.

The Planets

Mercury is an evening star all through the month, but is south of the sun, and so not very favorably placed. Even at his greatest elongation on the 18th, he sets only about an hour later than the sun.

Venus is a morning star, rising about 4:00 A. M. at the beginning of the month, and before 3:00 A. M. at its close, and is extremely bright.

Mars is in conjunction with the sun on the 21st, and is unobservable.

Jupiter is in Pisces and well placed for observation. He is due south at 11:14 P. M. on the 1st, and at 9:04 P. M. on the 31st.

Saturn is an evening star in Scorpio, setting a little after 7:00 P. M. in the middle of the month. Uranus is in Pisces, a little to the east of Jupiter, and is well observable telescopically. Neptune is a morning star, rising between 2:00 and 3:00 A. M.

The moon is in her first quarter at 9:00 P. M. on the 3rd; full at 4:00 P. M. on the 10th; in her last quarter at 10:00 A. M. on the 17th, and new at 11:00 A. M. on the 25th. She is nearest the earth on the 11th, and farther off on the 25th. While on her circuit of the heavens, she passes near Saturn on the 1st, Jupiter and Uranus on the 9th, Neptune on the 20th, Venus on the 21st, Mars on the 25th, Mercury on the 27th, and Saturn again on the 28th.

The Scientific American Digest

(*Continued from page* 348)

that has a British Thermal Unit cost approximately one-half of that of fuel oil, then," continues Mr. Jefferson, "it behooves the marine engineering fraternity to bestir itself and find out whether or not this type of power can not be put to work on ship board.

"That is the reason why the Fuel Conservation Committee decided to tackle the problem, for pulverized fuel has, on numerous shore plants, met the conditions just cited.

"But, if this has been worked out on shore, why should there be any marine installation problem?

"The answer to this is simply furnace design.

"In the average pulverized-fuel plant, where the rate of combustion has been less than a pound of fuel per cubic foot of furnace volume, deep or long furnaces have been used, which allowed flame travel of 20 feet, or more. This permitted comparatively slow flame propagation, or ignition of the individual particles of coal.

"This type of furnace design is not practical on ship board, and in the case of the Scotch marine boiler, it is not only impractical but impossible. The furnace of a Scotch boiler may be made smaller by installation of refractory lining, by accumulation of ashes and dirt, or by the collapse of the furnace, but it just cannot be made larger; it's not that sort of 'animal.'"

Explaining that the furnace of the ordinary Scotch boiler used on steamships allows only 11 feet for flame travel, instead of the needed 20 feet, Mr. Jefferson next tells how tests were made as long ago as 1921, in an effort to surmount this difficulty. It apparently became clear, however, that there was simply not enough combustion space in the boilers.

However, by 1925 the Fuel Conservation Committee was again convinced that further possible progress made along these same lines would eventually succeed.

"At almost the same time," says Mr. Jefferson, "further stimulus was given to the question by the numerous Diesel installations which have been made in the fleets of our foreign competitors.

"The fuel economy possible in a Diesel installation would drive steam off the seas, if it were not for the high initial cost of Dieselization. This high cost has retarded Dieselization considerably but has by no means stopped it, and the steam men have been forced into developing their equipment so as to reduce the differential in the operating fuel cost between the Diesel and the steam plant.

"High-pressure, high-temperature steam has received a considerable impetus and, with the reinforcement of pulverized fuel, it is possible to meet the challenge of the Diesel, not in terms of pounds of fuel per shaft horsepower, it is true, but in the terms which decide whether a business is profitable or not, that is, in the cost per shaft horsepower developed, and this with a plant whose initial cost will be materially less than that of the Diesel."

Summing up with a prediction ominous to the marine Diesel engine, the author concludes that "pulverized fuel for marine purposes has gone through a considerable amount of the development work which will make it real sea-going, but it is not quite ready to shove off. However, it does give most encouraging prospects, and it is safe to say that within a comparatively short time the marine engineer, in studying his operating costs, is going to be forced to consider another competition against the hand-fired coal or the oil-burning steam plant—a competition which will also question the superiority of the Diesel's operating costs and will have the advantage of a reasonable initial installation charge.

Cleaning Eggs With An Artificial Sandstorm

OWING to the drudgery involved in cleaning eggs for market and the bad effect of water and washing compounds ı the shell, a machine has been perfected ıd put into use which cleans the eggs by

Sandblasting eggs (1): The eggs are dumped three dozen at a time [illegible]veyor. They pass on at [illegible] blas

ıandblast and simplifies grading and :andling. Because of the excellent condition in which they reach the market, the ıandblasted eggs bring from one to four cents more per dozen than eggs cleaned by other means. They also have a higher ·ating for storage purposes, because the ·ormer method of cleaning with chemicals ıoftens the shell and speeds decomposition.

The egg-cleaning machine, several of which are in use in the Pacific northwest, has a capacity of 300 cases, or 9000 dozen eggs a day. The eggs are placed on a moving endless conveyor consisting of rubber-covered rolls. This conveyor carries them through the cleaner.

The rolls are so spaced as to prevent the ggs from falling through and are of such diameter as to keep adjacent eggs from touching one another. The motion of the rolls causes the eggs to rotate as they move from one end of the conveyor to the other.

The cleaner is a vertical compartment containing an ingenious sandblasting device. A fine grade of white sand is carried in a hopper in the tower of the cleaner. This passes downward through tubes to

Sandblasting eggs (2): Passing from the sandblast, the eggs are carried over a battery of powerful lights where they are candled

nozzles placed closely above the conveyor. Air, under low pressure, forces the sand in a fine spray upon the eggs as they are tumbled past the nozzles.

The cleaning compartment is enclosed and a vacuum is maintained by means of an exhaust fan. The dust is deposited outside the building. The sand falls into a pit in the base of the machine and is there picked up by bucket conveyors and carried back to the hopper. From the cleaner the eggs pass over powerful lights for candling.

At Last a Complete Astronomy

"THE most complete treatise on astronomy in the English language" is the accurate characterization applied by an astronomer friend of the reviewer, in speaking of Russell, Dugan and Stewart's "Astronomy" (Ginn and Company, 1927). For eight or ten years, until recently, there has been no thorough modern textbook of astronomy. Almost simultaneously several textbooks appeared in 1926 and 1927, but not one of them is based on so ambitious a plan as the splendid work under review.

The new work contains a total of 932 pages and is published in two volumes. Volume I is wholly devoted to the solar

Sandblasting eggs (3): The cleaned eggs emerge from the sandblasting chamber in a very short time and are next packed for shipment

system. Volume II treats of the stars and astrophysics. Thus the book is more than an astronomy in the ordinary sense of the word; it combines an astronomy and an astrophysics. The volumes may, if desired, be purchased separately. It is anticipated that the second, on astrophysics, will require relatively frequent revision; the first volume much less so.

Contrary to expectation in the case of a relatively exhaustive work of this sort, the text is not abstruse; algebra appears to be the "most terrible" form of mathematics employed and there is very little, even, of that.

The senior author is Dr. Henry Norris Russell of Princeton who for 27 years has conducted a monthly astronomical department for this magazine, while the junior authors are also members of the Department of Astronomy at Princeton University, of which Dr. Russell is head. It is altogether unlikely that any author will attempt as ambitious a work as this within a decade or more, and the work will therefore be likely for a long time to occupy the central position in the field of relatively exhaustive text and reference treatises on general astronomy.

New Electric Cable Works as Continuous Push Button

A NEW type of electric cable for small currents, such as those used for sounding bells and buzzers and for starting and stopping machinery, has been invented by a Hungarian electrical engineer of Berlin, Germany, Oscar Nagy. It does away with the necessity for having push buttons at set points, for if the cable is squeezed at any place throughout its length the circuit is completed and the current does its work. This is accomplished by having the wires woven into a sort of loose braid, separated by an elastic non-conductor, which permits contact when pressure is applied.

Many uses are suggested for the new cable. It is expected to find a large use around complicated machinery, where threatened accidents to either operator or material demand instant stopping. Since it can be operated with feet, knees, elbows, or any other part of the body, its advantage over ordinary types of switches and levers is obvious. Hidden beneath carpets or otherwise concealed, it is expected to be useful in burglar alarm systems. Strung along trenches, or along the sides of naval vessels, it will enable officers to signal to their men from any point, and by rapid successive pressures messages can be transmitted in ordinary Morse code, making it an emergency telegraph system.

An especially interesting safety application is found in its use in mines and quarries, where a fall or slide of rock automatically sounds its own emergency signal.—*Science Service.*

Helium Found in Canada

UP to the end of 1926, over 25,000,000 cubic feet of helium has been obtained by the United States Government, and costs of production reduced to a basis that will permit of commercial utilization. Helium was also extracted in small amounts in the experimental plant at Calgary, Canada, operated under the direction of Prof. J. C. McLennan, F.R.S. of the University of Toronto in 1919-1920, for the British admiralty.

In the survey of helium resources in Canada made by the Mines Branch of the Canadian Government, it was found that the gas from three small wells at Inglewood, Ontario, contained as high a percentage of helium as that treated in the United States Government plant at Fort Worth, Texas. The Ontario Government has since taken up many of the leases in this neighborhood and it is anticipated that the Canadian National Research Council may establish an experimental helium extraction plant, if it be proved that sufficient gas is available. A few wells in other fields in Ontario, particularly in Norfolk county, yield gas carrying 0.5 percent helium. Natural gas in Alberta, where much larger quantities are available than in Ontario, was found to contain little or no helium, with the exception of that from the Bow Island and Foremost fields. If natural gas, containing as little as 0.2 percent helium, could be economically processed to extract helium, it is calculated that about 5,000,000 cubic feet could be obtained in Canada annually. Canada is the only present known source of helium in the British Empire.

The results of this investigation are described in a report, "Helium in Canada," by Dr. R. T. Elworthy, recently issued by the Mines Branch. It contains a brief account of the particulars and occurrences of helium, the methods employed in the work, particulars of the gas fields, including analyses of many gases, and some account of the methods of recovery of helium and its uses. Copies may be obtained on application to the Director, Mines Branch, Department of Mines, Ottawa, Canada.

Cellulose Films May Revolutionize Photography

CELLULOSE, the principal constituent of wood fiber, may revolutionize photographic methods by its use in photographic films. A new process has just been developed by Philippe David, collaborator of A. Bertillon, famous criminologist, by means of which it takes the place of gelatin as a support for the sensitive silver salts.

In the ordinary photographic plate of film the base of glass or celluloid is coated with a layer of gelatin in which are suspended the silver bromide particles. The gelatin layer is rather delicate, and great care must be taken with the films or plates before they are dry. Too much heat will melt the coating and spoil the picture.

With the new films gelatin and its disadvantages are eliminated. As the cellulose does not dissolve even in boiling water, the developing chemicals may be used hot to speed up the process. They may be developed in three to four minutes, fixed in two minutes and washed in 80 seconds, instead of the 15 to 30 minutes that the latter process now takes. Then they can be dried over a flame or in a hot oven in two or three minutes. The entire process, from the start of development to the dry negative ready for printing, is over in 10 minutes at the most. This is a far shorter period than can be obtained at present, and it is anticipated that the new films and plates will prove especially valuable, both for still and motion pictures, in portraying news events.—*Science Service.*

Industries From Atoms

(*Continued from page 350*)

used has been ideal in this duplication of ordinary wear. In suggesting a new type of service test for rubber to be applied in the laboratory, Mr. Williams said to the American Chemical Society:

"Attempts to duplicate service conditions are responsible for the existence of a large variety of abrasion machines which in the final analysis are seen to be quite similar. Each machine gives due consideration to the abrasive, the area of rubber exposed, the pressure between abrasive and rubber, and the duration of the test or the amount of slipping, apparently on the assumption that the only remaining variable is the rubber itself. The mechanical differences in the abrasion machines arise largely from the different methods employed to produce slipping between the rubber and abrasive, and from this standpoint the various machines may be divided roughly into three classes:

"1—A flat rubber surface is moved against a flat abrasive surface in the same plane. The area of the rubber exposed to the abrasive is usually maintained constant in all tests and is pressed against the abrasive by a standard pressure. The test is usually conducted for a standard time at a fixed speed.

"2—The rubber, either a prepared disk or blocks attached to the periphery of a wheel, is rotated against a rotating abrasive surface, the two axes of rotation being neither perpendicular nor parallel. The amount of sliding action between the rubber and abrasive is determined by the relative position of the two axes. The load is maintained constant while the area of contact may remain constant or may increase, depending on the shape of test piece and the relative position of the axes. The test is usually conducted for a standard time at a fixed speed.

"3—The rubber is subjected to the impact of loose abrasive. The usual procedure consists in rapidly rotating a disk of rubber in a vessel of loose abrasive.

"Abrasion seems to be the process of wearing away the surface by friction and is an action which in itself involves only the surface layer. Motion between the rubber and the abrading surface is necessary and a force must be applied to create the motion. The product of this motion and force represents the amount of work which is actually done on the surface of the rubber. The uniform conditions of surface contact, load, and amount of slip which are generally imposed on the test sample do not assure the expenditure of a uniform amount of work, which under these uniform conditions is a direct function of the resistance to motion which the rubber exerts. This factor, which has formerly been neglected, may differ as much as 100 percent between two samples of rubber. Since the surface of the rubber can be removed only by the application of work, the measurement of volume loss on abrasion is incomplete without a simultaneous measurement of the total work expended on the rubber.

"The accompanying picture illustrates an abrasion machine proposed for measuring the volume loss of rubber per unit of work expended. The principle is that of a Prony brake in which the rubber test-pieces are made the friction surfaces of the

brake. The disk A, carrying the abrasive, is mounted on a hollow shaft and rotates in a vertical plane at a speed of 37 revolutions per minute. Two rubber test blocks, each two centimeters square and one centimeter thick, are mounted on the under side of the bar B, one being placed at each end and at a distance of four and one half inches (11.4 centimeters) apart. The bar B is permanently attached to a rod which extends through the hollow shaft carrying the abrasion disk. A weight E, attached to the end of this rod by means of a cord over a pulley, holds the test pieces against the abrasive. The lever arm, C, carries at the end an adjustable weight which is made just great enough to prevent the rotation of the bar B. This weight varies from 500 to 1000 grams. The spring balance, D, serves for the final adjustment of the load. The abrasive generally used is number 0 emery paper. The abrasive surface is cleaned by means of air jets which are not shown. Brushes are not efficient. This machine measures the volume loss in the usual manner which, together with the simultaneous measurement of rate of work, permits the calculation of volume loss per unit of work done."

Having discussed his new method of measurement of abrasion resistance, Mr. Williams goes on to consider the various factors influencing the life of a tire in service:

"The question of tread wear involves much more than the abrasion resistance of the tread stock. A tread can be worn away only by doing work on the surface. The work required to drive a car forward at a definite speed and for a definite distance against the normal rolling resistance could be determined, and this amount of work must be done on the rear tires, irrespective of the stock of which the treads are composed. Work is done on both front and rear tires due to rolling friction. This is caused by the difference in circumference of the tire at the center of the tread and at the tread shoulder which necessitates slip, and by the change in area of the inflated tire when it deflects to carry the load. The amount of work will depend on tread design with its effect on the amount of slip, on the coefficient of friction between the rubber and road surface, on the stress-strain relationship, and on the mechanical efficiency of the rubber. It is obvious that if the coefficient of friction could be reduced to zero, slipping would take place but no work would be done. If the coefficient of friction could be made infinitely great, no slipping would occur and no work would be done on the surface, but the stress due to the strain resulting in the rubber would be stored in the rubber in a reversible manner. Under normal conditions both slip and strain in the rubber result. Any point on the tread of a tire at the time of coming into contact with the road will slip until the pressure against the road increases to a definite value, which depends upon the existing coefficient of friction and the stress-strain relationship of the rubber, after which energy is stored in the rubber due to the strain imposed. As the rolling motion of the tire proceeds until the point of the tread is about to leave the road, any energy stored in the rubber due to strain will be available to cause slip and do work on the surface of the rubber.

"Many of these factors are extremely variable under road conditions and tend

to be minimized by dusty or wet roads which reduce the friction. While the work done on the rear tires due to driving force and on the front tires due to steering thrust must be constant for any tread stock, the work due to rolling, camber, and toe-in will vary with the road conditions and tread compound. While the present development of the abrasion machine makes possible a comparison of the abrasion resistance of any compound, it should not be expected to replace actual road tests in the selection of a tire tread."

Life of Lacquer Films

THE increasing use of nitrocellulose lacquers has induced an investigation of the effect of sunlight upon them by the Bureau of Standards. L. L. Steele reports on this investigation in *Industrial and Engineering Chemistry* in part as follows:

"Sunlight is known to be a very important factor in the decay of oil-varnish films exposed outdoors. The destructive action of sunlight, often ascribed to the ultra-violet rays, is perhaps even more marked in the case of clear nitrocellulose lacquer films exposed to the weather. In the case of the oil varnish it is probable that brittleness of the film, which causes cracking and eventual failure, is due to a slow, continuous oxidation of the drying oil originally present under the catalytic effect of the sun's rays. Lacquers do not dry through oxidation as do oil varnishes; therefore, their failure in the weather can hardly arise from over-oxidation. Their failure is probably caused mainly by hydrolytic splitting of the cellulose ester. Nitric acid is a product of such hydrolysis and would be expected to act as a catalyst in the splitting of additional portions of the cellulose ester, so that once decomposition starts it would be expected to proceed rapidly.

"The evident effect of sunlight in splitting nitric acid from the nitrocellulose in a lacquer film was indicated in the following simple experiment: To a commercial clear lacquer there was added approximately 1 percent by weight of dimethylaniline. Films of this mixture were prepared on sheets of clean steel. These films showed no appreciable coloration after several hours in the laboratory but developed a characteristic green color within five minutes when placed in direct sunlight. Photographic prints were obtained by placing a negative over one of the lacquer films and exposing to sunlight. This indicated that the green coloration was produced by light rays and was not due to a heating effect. A plausible explanation for the green coloration is that oxides of nitrogen were liberated in the film through the action of sunlight and combined with the dimethylaniline present to form the green derivative, *p*-nitrosodimethylaniline.

"In general it was found that the very strong bases, such as *iso*-allylamine, benzylamine, piperidine, et cetera, were detrimental in the nitrocellulose film. Many compounds appeared to have no effect on the life of the film. Urea and asparagine are in this class, but it should be noted that these compounds did not dissolve completely in the solvents present in the lacquer. Hippuric acid and oxamide appeared to accelerate decomposition although they were only partially dissolved. It is interesting to note that aniline appeared to be neutral in its effect in the nitrocellulose film while bromoaniline and especially *m*-nitroaniline appeared to have a beneficial

effect. The greater vapor pressure of aniline might account for this difference. The most effective compound in prolonging the life of the nitrocellulose film was diphenylamine. This is noteworthy in view of the use of this material for the stabilization of smokeless powder. The brown coloration of the film containing diphenylamine caused by sunlight would probably be a serious drawback to its use as a stabilizer in commercial lacquers. Other derivatives which appeared to act as stabilizers also showed a similar defect of discoloration in sunlight."

Lubricating Oils as Insecticides

THE possibility of using oils of the type of lubricating oil in combating insect pests on plants has led to a careful investigation of this subject by E. L. Green of the State College of Washington. In reporting his results in *Industrial Engineering Chemistry*, Mr. Green concludes from studies of spraying during the dormant period, before the plants' leaves are out:

"The property of killing insects under the conditions of this study resides in a considerable range of lubricating oils, but is greatest in the portion that distills over between 240 degrees and 300 degrees, Centigrade, at 40 millimeters pressure.

"Toxicity of the kind studied does not appear to be related to the viscosity of the oils.

"The presence of significant quantities of vapor or vapor pressure is doubtful, in view of the low field temperatures and the high boiling ranges of effective oils.

"Oils for this purpose may be from asphalt or paraffin-base crude without prejudice to the effects.

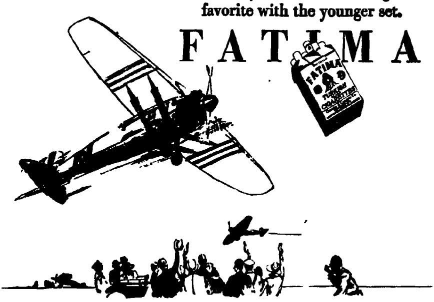
"Oils that have been subjected to processes for completely removing the color are likely to be more effective than before the decolorizing treatment."

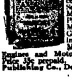
Oil "Discoveries"

SO frequent have been the reports of discoveries of oil which have had no more foundation than spillage on the surface of the ground, that the Geological Survey has issued a general statement on the subject. This statement says:

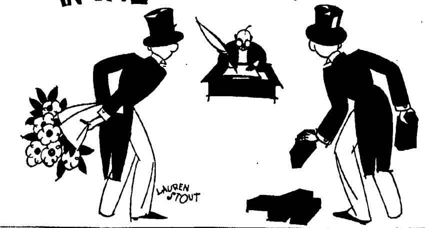
"In a large number of cases, these reports lead to local excitement and the hope that the material indicates natural occurrences of crude oil which can be developed commercially. These reports come from all sorts of geologically impossible locations. They may be in regions where the underlying rocks are Archean or granites as well as in regions where the underlying rocks are sediments not intrinsically hopeless as sources of oils.

"We believe that in practically all such cases the reported occurrences are due to contamination of the soils from filling stations or other sources of refinery products. Of course, there are a few occurrences of particularly high-grade natural petroleums which contain as much as 80 or even 85 percent gasoline, but even these highest grade crudes do not possess the chemical and physical properties of gasoline. They are likely to have a notable difference in distillation range. No cases have come to our attention in which the laboratory technician is not able to determine whether the material submitted is a fugitive distilled product or a mixture of products, on the one hand, or a natural product on the other."





IN THE EDITOR'S MAIL



Chemistry "As She Is Taught" Out West

SEEING is believing. Those in charge of the Bakersfield, California, High School evidently understand this fact. To teach chemistry, especially where it touches on geology and mining, they get up each year a desert automobile caravan. The classes go and see things for themselves. Then they remember. This is real education, not merely "book learning." But let Mr. Mark Wilcox of that community tell it:

Editor, SCIENTIFIC AMERICAN:

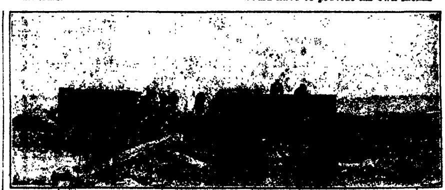
Here is one chemistry class that has a chance to realize how ... some of its phases may affect the lives of many people in the community. Bakersfield High School, in the center of one of the richest oil and mineral regions in California, has as its instructor in Junior College chemistry a man who is both an expert in petroleum technology and the county assayer of minerals.

Classes under the guidance of R. E. ... thin a few miles of Bakersfield; but the big event of the year for the chemistry students is the annual excursion of the boys to the mines in the neighboring mountains. For seven years Mr. Vivian has been piloting the boys on journeys of ever increasing length and diversity of experience.

The boys pack their own grub and blankets and sleep on the ground; they enjoy playing the part of seasoned prospectors. Memories of personal adventures in the observation of mining processes are brought home by the boys, and they will doubtless remem- ... ments of the laboratory have been forgotten.

When it was announced this year that the trip was to be more extended than ever, all the boys wanted to go. They were to visit the mines in and around Death Valley and would be gone at least four days. Each boy would have to provide his own means


Chemistry class ready to start from Bakersfield High School


Old borax wagons in Death Valley, abandoned for railway and motor trucks

of conveyance, of course, and this requirement eliminated several. But at last over 40 boys assembled in all sorts of cars from little strip-downs to seven-passenger sedans. Thirteen cars—some caravan!

What did they see? They saw gold ore, of course. After all these years since 1849 there is still gold to be found in paying quantities in the mountains of California and the neighboring state of Nevada. With the gold they also saw silver and lead and zinc. The boys were surprised to learn that these metals are usually found together in the same ore although in different proportions and chemical combinations. In the famous old Yellow Aster gold mine, for example, much silver is recovered. At the California Rand silver mine, on the other hand, which has taken millions of dollars' worth of silver out of deep holes in the ground within the last ten years, thousands of dollars worth of gold is also annually extracted.

One of the students examining specimens of ore in Darwin mine

What they really saw, of course, was a white or reddish white rock with peculiar dull blue or yellow streaks in it. They had to take Mr. Vivian's word for it that they were looking at gold or lead or silver ore! But after they had been through the huge concentrating mills at Darwin and at Randsburg, and had seen how this streaked rock was ground to a powder and mixed with water to form a grayish, pasty-looking mud, before the precious metals could be recovered by further intricate processes, they began to realize that gold mining is no occupation for a poor man. As one boy naively remarked, "I can see now, Professor, why gold costs so much!"

They also visited a soda plant, where the waters of an alkali lake are turned into baking and washing soda, and they saw on the eastern side of Death Valley the great borax mines and mills of "Twenty-Mule Team" fame. As this was an educational trip they wanted to visit as many different types

of mines as possible while on the trip.

One of the requirements for participation in this great adventure was that each boy should report to his chemistry teacher what he had gained. All of them dwelt, over-much, perhaps, on the good time they had had roughing it. But a few of the older boys were

a thing actually done than by reading about it. Also this trip was a great

geology (

through and about processes used in the mills we visited. But I believe that I will remember the trip best because I learned first hand the secret of the desert country—of the charm of its vast desolations that is dreadfully forbidding unless one comes willing to appreciate its sombre beauty."

Another boy who is a "shark" at chemistry and whose report bristled with chemical formulas concluded with this inspired outburst: "I would give most anything for a picture, colored naturally, of the Mojave Desert as we saw it. The view was always changing. At one spot we would be in a flower bed, a blaze of blue and gold and yellow; a few miles farther ... derful velvety green; and yet a little farther, nothing but desolate sand covered with greasewood and cactus. From the floor of Death Valley in the center of an awful waste of sand and shimmering heat waves, we could see the peak of Mt. Whitney, the highest spot in the United States, and that peak was covered with snow. Yes, it would be worth taking the trip to see the scenery alone."

Looking after so many carloads of boys was quite a task, Mr. Vivian admits; but thorough organization and careful planning made it comparatively easy. At every fork in the road, for example, where there was a chance of any one going astray, Mr. Vivian would wait or have one of the older boys wait until every member of the party had passed. Each machine carried extra gas and oil and water, and they were all expected to keep together in order to help each other in case of need.

Whether they remember anything about mines and mining these lads will know better how to handle themselves in desert country, if they ever want to try it again.

Mark F. Wilcox.

The Bee Comes to the Aid of the Telescope Maker

THE editors fully anticipated as they began their telescope-making campaign 18 months ago that when several thousand SCIENTIFIC AMERICAN readers were turned loose on certain of the problems involved in this work, one or more of them would discover some new and valuable basic principle. And so it has turned out In the following communication Mr Russell W. Porter of Springfield, Vermont who has closely collaborated with our staff in helping make a success of the amateur telescope-making campaign, releases to the amateur fraternity the latest secret:

Editor, SCIENTIFIC AMERICAN:

At a recent convention of a telescope enthusiasts held at " fane," Springfield, ...

tirely new technique of polishing their mirrors was brought to light that will prove a great boon to the large and increasing body of young men in this country devoted to the making of concave mirrors for reflecting telescopes. I have given the method a thorough tryout and find it has several advantages over the time-honored process of polishing on a lap of pitch.

Newton, in the 17th century, found that properly tempered pitch served admirably for a bed on which a finely-ground glass surface could be brought to a complete polish, and it is still used for polishing and figuring optical surfaces, such as lenses, prisms, flats, et cetera. However, making a pitch lap is somewhat of a trial to the amateur and has been adequately described as a "mussy" job.

It is here that the humble bee comes to the rescue. Apiarists are now using what they call a "comb foundation" which they place in the hives. On this the bees build up their honeycombs. This foundation is an artificial sheet of pure beeswax whose surface is covered with a network of small hexagonal depressions. Its thickness varies, but averages about a sixteenth of an inch. If one of these sheets of wax is now spread over the glass tool of the mirror maker, he has a lap ready for polishing and can forget his pitch entirely.

My first surprise on trying this novel polisher was the perfect uniformity with which the glass began to polish. It would seem that the structure of this comb foundation provides a cushioning effect that gives uniform contact with the glass from the start. The tiny wax partitions making up the hexagonal pattern slowly spread under the pressure and heat of polishing, accelerating the polish as the work progresses.

As the last pits disappeared from my test disk (five inches in diameter) I looked at the clock and was astounded to see that the glass had been brought to a complete polish in about two hours. When it is understood that seven to nine hours are usually required to polish on pitch, no further comment is necessary.

When the speculum maker has polished his mirror he "figures" it; that is, he laboriously wears away parts of the glass until it reaches a surface of revolution known as a paraboloid. To accomplish this, certain parts of the pitch lap are cut away in order to bring the abrading action upon the part of the glass where it is needed. For the amateur this means perhaps that he must make over his lap several times, each time going through the "mussy" job previously alluded to.

With comb foundation, however, any desired lap may be cut out and used, stripped off the tool and another quickly substituted. The sheets adhere readily to the tool if the tool is first smeared with turpentine and any excess wiped off. The sheets come in rectangles seven by 14 inches and cost about 12 cents apiece. I had no difficulty in obtaining them of a bee keeper in my community and I imagine they are equally available elsewhere. For mirrors over seven inches diameter, two sheets may be joined, or butted, and a lap built up to any size required. Moreover, they may be built up one upon the other to any desired thickness.

Withal, no better medium could have been designed for convenient and efficient mirror polishing than this product of the bee keeper.

Incidentally we must thank such gatherings as the one held at "Stellafane" [See mention of this meeting in Digest department—Editor] for dis-

seminating and making available information such as the above.

Finally, the person to whom we are directly indebted for this method of glass polishing is Mr. A. W. Everest of Pittsfield, Massachusetts. Mr. Everest brought with him to "Stellafane" a ten-inch mirror which underwent a gruelling examination on test objects, and although the seeing was only fair, it stood up beautifully with his quarter-inch ocular, readily resolving the components of *Epsilon Lyrae*.

R. W. Porter.
"Stellafane," Springfield, Vermont.

Cavalry Colonel Makes Reflecting Telescope

THE recent publication of the SCIENTIFIC AMERICAN book "Amateur Telescope Making," containing instructions for making several types of medium sized reflecting telescopes (also lists of manufacturers from whom the materials may be purchased) seems to have awakened ever spreading interest in this fascinating work. Here is a short letter from an army officer who has evidently completed his telescope

Colonel Moffet and his home-made telescope. The two axes are old Ford axles, the brake drums being used for the setting circles

and is satisfied with it. Such an instrument will magnify 100 diameters.

Telescope editor, SCIENTIFIC AMERICAN

Your kind note regarding the telescope merited an earlier reply, but I did not have the photograph and weather conditions were not favorable. But here is one. I doubt if you will care to use it, as there is very little originality in the job. I followed directions pretty generally. While the mirror is clearly not perfect, it is wonderful what it will bring to sight in the heavens. Have not purchased any mirrors or lenses, but made diagonal and eye-pieces myself. Probably will get even better results when I see fit to buy better accessories.

The entire cost of reflector and mounting complete was just about 50 dollars. I was rather surprised that it could be done for that sum, as that was the proposed expense for the simple wooden mounting.

W. P. Moffet,
Lieutenant Colonel, Cavalry,
United States Army.

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HISTORY OF THE INCANDESCENT LAMP

By J. W. Howell and Henry Schroeder.

Probably no single invention has affected modern progress and comfort more than Edison's discovery of the vacuum bulb electric light. It is eminently fitting therefore that all the facts in connection therewith be recorded while the correct and accurate data are obtainable. This has been done by the authors in a most interesting manner.

The Maqua Company. (Gratis)

For Sale by SCIENTIFIC AMERICAN

Commercial Property News

A Department of Facts and Notes of Interest to Patentees and Owners of Trademark Rights

CONDUCTED BY MILTON WRIGHT

Co-operation Among Inventors

LIKE other birds, inventors sometimes exhibit a tendency to flock together. Their object is mutual aid in protecting, developing and promoting their inventions. An effort to effect such co-operation is suggested by one of our readers in the following letter:

"Many an invention has never been brought to a successful conclusion—many an invention has not gone any further than just being thought about—many has died with the death of its inventor—all because there has been a lack of funds for experimenting, for testing and for perfecting the idea.

"Would you approve of a banding together of men with ideas to overcome obstacles? Would you assist these same men in co-operating to carry out their ideas in accordance with the following plan?

"Each inventor interested in this project would pay a fee of 100 dollars for a life membership. The money thus raised would be used for leasing property to be used as a laboratory, machine shop, drafting department, club room and other facilities. Each member would submit his idea for approval to an Advisory Board for criticism and recommendations for improvement. The inventor would also submit 'a bill of material' which would be filled from the supply of the organization at cost. The member would then be allotted a time for using the machine shop, drafting room or laboratory of the organization, and in the course of his experiment, questions or difficulties which might hamper the successful conclusion of his work would be submitted in writing to the Advisory Board which would render to him any service it would deem best.

"The organization would become self-supporting after a number of members had successfully marketed their inventions, for a stipulation would have been included in the membership agreement, providing that a certain percentage of moneys received from the sale or lease of patents or patented articles would go to the organization.

"Any assistance you can give me or anything you can do to start publicity for the formation of such an association of inventors would be deeply appreciated, not only by the writer, but I believe by the numerous persons whom it would affect."

Such an undertaking as Mr. Rogen suggests is interesting and praiseworthy. There have been organizations which, on the face of them, seem to be very much like the organization in mind. Most of them, however, were fake concerns whose principal object seemed to be to make as much money as possible out of inventors. A real honest-to-goodness organization, such as he plans, might be feasible, but there is this theory which would tend to work against it:

An inventor usually is interested in his own invention and in nobody's else. The mere fact that he lacks equipment in perfecting his idea generally is not an obstacle. In fact, one of America's most distinguished inventors told us recently that he considered it a decided advantage for an inventor not to have too much equipment at his command. Not only is each inventor not interested in other inventors, but he is likely to look upon the inventions of others as impractical or at least not as valuable as his own. As a matter of fact, many inventors who would join such an organization would be men with impractical ideas.

Refusals do not Imply Lack of Merit

HOW many an inventor there is whose invention is turned down by a big corporation, but meets with success when the inventor promotes it himself! Such is Samuel S. McKnight, who has just won a victory in the courts over the D. B. A. Burns Bottling Machine Company for the infringement of his patent.

McKnight invented a crown feed for an automatic crown bottling machine and obtained a patent which contained only one claim. He offered his invention to the Crown Cork and Seal Company, but the company declined it. At this time Burns was foreman of repairs for the company. Soon afterwards Burns left and founded a concern for the repair of crown bottling machines. Later, when rebuilding certain machines, Burns installed in them an improved means for delivery of the crowns. It was substantially similar to McKnight's in most respects. McKnight sued the Burns Company for infringement.

Of the value of McKnight's single claim Judge Soper in the Maryland Federal District Court says:

"The evidence proves not only the novelty but the utility of the device in a crowded art. Troublesome difficulties and delays in the delivery of crowns in

Patents Recently Issued

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Official copies of any patents listed in this section at 15c each; state patent number to insure receipt of desired patent copy.

Pertaining to Aeronautics

WING STRUCTURE FOR AIRCRAFT—Which enables aircraft having two, or more, superposed wing surfaces, to vary the surface angles, with the result that the flying speed can be varied, at constant engine speed. Patent 1628625. A. Tammeo. c/o G. Capuccio, Via Arsenale N. 17, Surin, Italy.

AERIAL RAILWAY—In the form of a monorail vehicle which may be quickly loaded and unloaded, and readily turned to reverse its direction especially adapted for short runs. Patent 1636619. F. P. Archer, 107 No. Franklin St., Wilkes-Barre, Pa.

Pertaining to Apparel

GARMENT—A diaper cover, of water-proof material slitted from the waist band, providing a ventilating opening and permitting the cover to be readily placed on a child. Patent 1627771. J. H. Dwork, c/o Red Raven Rubber Co., 153 Sussex Ave., Newark, N. J.

TIE—So constructed that no matter how much subjected to tension, it will resume its normal position when released, and will not lose its shape. Patent 1635946. H. B. Mapou, % J. M. Green Co., 7 E. 20th St., New York, N. Y.

SHOE LACE—Wherein elastic lacing members are used simulating ordinary laces, and interlocking metal members are provided for holding the front of the shoe together. Patent 1635884. M. K. Gilewicz. 600 E. 139 St., New York, N. Y.

Chemical Processes

FIREPROOF COMPOSITION—For materials on walls, of such consistency that it may be sprayed, the composition comprises of a mixture of asbestos, flour, lye, and salt dissolved in water. Patent 1628171. A. McIntyre, 2510 So. 2nd Ave., Billings, Mont.

TREATING HYDROCARBON OILS—A process whereby hydrocarbon oil is passed through heating coils, vaporized, and when free hydrogen introduced for the production of water white oil of the gasoline series. Patent 1628532. W. L. Coultas, Jr., Seaford, N. Y.

Electrical Devices

GAS IGNITING DEVICE—An electric gas lighter, using the ordinary house lighting current, or a battery current, designed for automatically igniting a gas stove when the burner is turned on. Patent 1635104. S. J. Woods. 10 Burdick Ave., Newport, R. I.

PROCESS AND APPARATUS FOR RECHARGING MAGNETS—Especially designed for recharging magnets that form part of magnetos, at a minimum cost of electrical energy, and while the parts are in their normal position. Patent 1636941. S. V. Losey, 8745 Dunbarton Rd, Detroit, Mich.

TELEGRAPH TRANSMITTER—Movable a relatively short distance for interruption of the circuit to transmit dots, and a slightly longer distance in the opposite direction in the transmission of dashes. Patent 1627819. J. B. Youngblood, 1622 Dublin St., New Orleans, La.

existing automatic capping machines were obviated and mechanical parts were eliminated. Practical success was achieved in a number of factories under the supervision of the patentee and also in the machines equipped with what we shall see to be the infringing device of the defendant."

After comparing the two machines the court grants an injunction against the Burns Company.

Trademarks in Translation

WHEN a German firm some time ago applied in Japan for registration of the trademark "Purit" the Examiner refused to register it because of the prior registration of "Flit" by an American firm for the same class of goods. Only after a vigorously fought appeal was the mark registered over the Examiner's objection that the words are deceptively similar.

The similarity lies in the fact that when the two words are translated into Japanese, "Purit" is spelled "Fu (with a dot)-ri-t-to" and "Flit" becomes "Fu-ri-t-to." All of which goes to show that a trademark which may be pie in one country is applesauce in another.

Where Delay Proved Fatal

DELAY in applying for a patent often is fatal. Such has proved to be the case with Cortlandt F. Flake whose application for a patent, after going through the Patent Office, finally has a denied by the Court of Appeals the District of Columbia.

The invention in question relates to method of preserving fresh citrus fruit by treating it with a thin coating of paraffine dissolved in gasoline or some other volatile solvent of paraffine. Prior to the invention, citrus fruits when being prepared for market were mechanically brushed with paraffine as a means chiefly of preserving their color, but were not so coated as to preserve them in a fresh condition.

In the winter of 1915-16, Flake was employed in a Florida fruit-packing house, and one of his duties was to adjust the blocks of paraffine so that the polishing brushes would take up sufficient paraffine to polish the fruit as it passed them.

Flake alleged that the difficulties of this operation led him to dissolve the paraffine in gasoline and pour the solution upon the polishing brushes, and that as a result of this experience he conceived the idea of using such a solution for coating the fruit. The testimony discloses that Flake experimented along this line, and disclosed the subject to others.

Meantime, Rex de Ore McDill conceived the invention and reduced it to practice it in October, 1920. He moved promptly to bring the invention into use in the citrus industry in Florida and on January 12, 1921, he applied for a patent. By a mistake he used the word "petroleum" in his application instead of "gasoline," but the circumstance showed his promptness. He made a new application in November of the same year.

In the season of 1921-22 Flake bought some of McDill's preparation and used it, but it was not until March 1, 1922, that Flake applied for a patent. He alleged conception, reduction to practice and disclosure as early as January, 1916. In denying his application and awarding priority to McDill, the court, Chief Judge Martin writing the opinion, declares:

"The examiner of interferences held upon the evidence that Flake's experiments were not regarded by him as a reduction to practice, but were desultory, and in legal contemplation were abandoned experiments; that he did not show diligence from October, 1920, when McDill entered the field, until his (Flake's) filing date; and that he is not entitled to prevail.

"We agree with this [illegible] the reasons stated by the examiner, which need not be further repeated here."

SOLENOID MOTOR.—In which the interruption of current in the solenoid, by reason of the actuation of a plurality of armatures, produces power which can be made use of. Patent 1635-935. A. F. Godefroy, 3506 Olive St., St. Louis, Mo.

ELECTROMAGNETIC RELAY — Particularly adapted to uses in pipe organs, the contacts being mounted in a novel manner, their removal leaving other parts undisturbed. Patent 1636609 A. A. Klann, Waynesboro, Park Station, Va.

COUPLING.—An automatic coupling which includes mechanical coupling members dependent for their effective action on the holding power of an associated electro-magnet. Patent 1635-144. W. G. Stevens, Jr. 100 W. 55 St., New York, N. Y.

NON-RESONANT DIAPHRAGM.—Adapted for use in electric microphones and receivers generally, permitting the tone values to be transmitted in an extremely natural manner. Patent 1637248. E. Reiss, c/o Messrs. Fehlert, Loubier, Harmsen and Buttner, S. W. 61 Belle Allianceplatz 17, Berlin, Germany.

Medical and Surgical Devices

DIAGNOSTIC DEVICE.—To record the difference in temperature between healthy tissue and organic inflammation of interest to physicians, surgeons and diagnosticians. Patent No. 1622887. William Smith, 53 South Broadway, Yonkers, N. Y.

MASSAGING DEVICE.—Which may be adjusted to cause the rollers to engage the flesh with a kneading or fingering action, for effecting increased circulation. Patent 1631792. W. B. Burnley, 6533 Meridian St., Los Angeles, Calif.

BONE CLAMP.—An instrument with which the two sections of a broken bone may be held in properly aligned position, until the ordinarily used plaster cast hardens. Patent 1635137. C. E. Mullens, 99 Washington Ave., Albany, N. Y.

Musical Devices

MUSICAL INSTRUMENT.—A wind instrument of the all-metal type, in which vibrating reeds or similar devices are eliminated, played in the manner of a harmonica. Patent 1631862. W. Hansell, 33rd & 3rd Ave., Brooklyn, N. Y.

BANJO.—With novel means for causing the tone to have a clear, metallic ring, and for setting free the sound waves by a sound reflecting member. Patent 1631293. H. H. Slingerland, c/o Slingerland Banjo Co., 1815 Orchard St., Chicago, Ill.

HARMONICA.—An attachment for harmonicas of conventional construction, having means for controlling the volume of music, also serving as a handle for supporting the instrument. Patent 1637289. W. B. Yates, Manitou Colo.

CIPHERLESS DEVICE FOR PIPE ORGANS.—By means of which an entire chest may be thrown out of action should one of the pipes in said chest continue to sound, thus producing a cipher. Patent 1632657. G. H. Kloehs, c/o United States Pipe Organ Co., Crum Lynne, Pa.

Of Interest to Farmers

COTTON PICKER.—In which the drums have radial picking fingers driven by novel constantly meshing gears, easily controlled, doing away with belts and pulleys. Patent 1635161. H. N. Berry, c/o H. A. Gamble, Greenly Bldg., Greenville, Mississippi.

Of General Interest

CHECK PROTECTOR.—A device included in an ordinary pocket knife, for roughening a portion of the paper after writing a check. Patent 1631863. R. I. Harris, Punta Gorda, Fla.

Inventions for Uncle Sam

"CAN you advise me how I can get in touch with the man who handles inventions for the government? I have an invention which is of no use to anyone except the government itself. I know it is practical and I have seen where it is needed. After seeing how much money is lost because of the lack of such an invention as mine, I am convinced that this invention will save the government approximately, 1,000,000 dollars every three to five years."

So writes an inventor to the editor of this department. What his invention is he does not say. His letter will serve, however, as a text for a little discourse on a phase of marketing inventions about which many inventors are a bit hazy.

There is no individual, committee, bureau or agency whose purpose is to accept inventions generally on behalf of the government. As a rule, the government does not buy inventions. There are a few exceptions to this rule; such an exception might occur in the case of a new type of anti-aircraft gun or a piece of apparatus used in the manufacture of paper money—cases where it would be desirable to prevent others from using the invention.

Usually, however, the government has no interest in acquiring a patent. This, we believe, is entirely logical. Let us assume that the invention in question is a stamp-cancelling machine which would save the post offices many thousands of dollars yearly. The Postmaster General, we will say, has seen it and wants it installed in his offices throughout the country. Should he buy the patent? He should not.

A patent is a monopoly. It gives to the owner the right to prevent other persons from making, selling or using the invention to which it applies. The government is not interested in preventing others from benefitting themselves or their businesses. The stamp-cancelling machine might be adapted to cancelling checks in a bank. The government would not want to prevent the banks from performing a necessary operation more cheaply and efficiently.

Does this sound discouraging for inventors? Not at all. The government buys equipment from manufacturers. Sell your patent to the manufacturer or lease it to him on a royalty basis. He gets his profit from the goverment; the inventor gets his share from the manufacturer. It works out just as well for the inventor as if the government purchased the intangible patent rights from one person and

EXTENSION-LEG ATTACHMENT FOR LADDERS.--For supporting a ladder firmly on a level surface, or to prevent slipping on an inclined or irregular surface of a roof. Patent 1631513. F. F. Berry, Box 437, Concord, N. H.

BALE-BAND BUCKLE.—Especially adapted for use in firmly and securely holding bands around cotton bales, but also adapted for tying bands around other commodities. Patent 1631402. T. J. M. Daly, c/o S. E. Compress & Warehouse Co., Atlanta, Ga.

SPRING CLIP BINDING POST—One operation manufacture. Takes all Tips. Wires inserted with one hand. Not necessary to sever continuous leads. Patent 1598003. B. A. Parrott, 73 Orchard Park Blvd., Toronto, Canada.

CIGARETTE CASE—Which can be stamped with one die, from one piece of leather or metal, adapted to form a case as well as holder for lighter. Patent 1628590. D. W. Greene, c/o Max E. Bernhardt, 127 W. 30th St., New York, N. Y.

BOTTLE-STOPPER SEAL—Wherein means are presented for destroying the label before the stopper can be removed, and positively indicate that the bottle has been opened. Patent 1628555. H. G. Pepino, 235 Ditmars Ave., Astoria, L. I., N. Y.

WIG FOR DOLLS—The principal part of which may be formed from a straight flexible structure capable of being distorted until it fits the head. Patent 1628591. P. Harris, 102 Wooster St., New York, N. Y.

CIGAR CUTTER—Comprising a receiving member, and a cutting or perforating member, which automatically functions to cut the cigar end. Patent 1628570. T. H. Ander- ... fax E. Bernhardt, 127 W. 30th ... ork, N. Y.

COFFEE-POT--Of the perculator type, which operates to perculate and simultaneously filter the coffee, preventing burning of the finer grains, and leaving a greatly clarified liquid. Patent 1624606. F. E. Lane, 1357 9th St., Douglas, Arizona.

suited for attachment so bent poles or other locations where nails might be undesirable or damage the pole. Patent 1628623. L. Jonnes, Circleville, Ohio.

MORTAR-APPLYING DEVICE—Designed to facilitate the manual application of mortar to the connecting ends of pipe sections, particularly pipes for irrigation purposes, forming a liquid-tight joint. Patent 1626-972. A. H. Sanders, 342 North Vista Bonita Ave., Glendora, Calif.

INK DISPENSER—For printer's ink, effectively protecting the ink against evaporation when not in use, and manually operable to dispense ink in any quantity. Patent 1632473 W. R. Greenland, 2054 Cambridge St., Los Angeles, Calif.

CRATE—A crate structure having a slatted bottom, and a hanger and brace element which rigidly support the bottom in proper position to the body. Patent 1635133. J. F. Maurer, Jr. Woodcliff, North Bergen, N. J.

MONOGRAM—Made up of separate letters readily association to constitute an apparently solid monogram, without special skill or special tools, adapted for automobiles, or other uses. Patent 1635077. J. E. Erskine, 21st St. and Talleyrand Ave., Jacksonville, Fla.

LINE PULLEY—For clothes lines, formed of rust-proof materials, and mounted in a cylindrical housing ready for use at all times. Patent 1635145. A. W. Taylor, 626 Jenkins Ave., Pechville, Pa.

SPRAY—The fluid supply pipe forming a trap in which a supply will be maintained, thus saving power, the device may be used for liquid or powdered insecticides. Patent 1635069, A. G. Bulle Villegas 23 Y 25, Havana, Cuba.

DISPENSING-CONTAINER SEALING DEVICE—Having means for preventing suprious refilling, whereby when the seal has been broken a special closure plug prevents spilling of contents. Patent 1635122. C. D. Henriques, 52 Chatsworth Ave., Larchmont, N. Y.

OVERJACKET FOR MOLDS—Intended to be fitted over a sand mold after removal of the usual flask to prevent bursting out of the molten metal. Patent 1635074. A. Diehl, c/o G. B. Smith, Atty, 407 Bushnell Bldg., Springfield, Ohio.

WINDOW SEAL—For preventing the entrance of cold air, or dust between the meeting rails of the sashes, and between the sashes and the frame, without weather strips. Patent 1635076. A. C. Enochs, 401 Scott Thompson Bldg., Oklahoma City, Okla.

Hardware and Tools

GUTTER HANGER—For supporting gutters adjacent the roof, by not only embracing the gutter bottom exterior, but for straddling the top of the trough. Patent 16622 (Reissue) C. Meunier, c/o C. A. M. Mfg. Co., Great Neck, L. I., N. Y.

FUR STRETCHING AND NAILING DEVICE—A portable device for effecting the stretching and nailing of the fur, or skin, to conform to the outline of a coat pattern. Patent 1628588. S Friedman, c/o Reliable Machine Works, 238 Eagle Ave., Brooklyn, N. Y.

DOOR-HOLDING DEVICE—For holding doors and simillar closures in open or partially open position, may be swung to and fro and secured in inactive position when not in use. Patent 1626007. C. B. ... 5019½ Noneta Ave., Los Angeles, C...

EXPANSIVE DRILL BIT FOR CABLE TOOLS AND THE LIKE--Which may be operated as an underreamer for reaming a hole already drilled under a casing to such size that the casing will freely pass. Patent 1637268. J. P. Miller, Houma, La.

...VATOR—A grapple or lifting hook for hoisting rods or other objects, securely holding them although they may be easily associated ...

B. Woods, Holdenville, Okla.

RATCHET DRILL—Which can be operated in a place of a relatively slight area, and can be adjusted to turn the tool in either of two opposite directions. Patent 1635882. H. W. Barbour, New Bern, N. C.

Machines and Mechanical Devices

DIES--Especially adapted for Bevelling Angles and Flanging Plates and Bars COLD, can be fitted to Punching Machine or Hydraulic Press. Patent 1633744. Geo. Hughes 411 Palmer Ave., Maywood, New Jersey.

DEVICE FOR FINISHING CONCRETE SURFACES—For rolling flat surfaces in such manner that the coarse material is forced below, enabling the surface to be smoothly finished without extra top layer. Patent 1623142. C. S. Walsh, 537 Progress Peace, Los Angeles, Cal.

AUTOMATIC BELT GUIDE—With novel automatic weans for returning the belt to a central position should it move sidewise no matter which direction the conveyer is running. Patent 1628615. B. Ross, 6219 Kenwood Ave., Chicago, Ill.

OIL PUMPS—Having two or more pumping units operating in such a manner as to prevent sand or other solids from settling in or on the valves. Patent 1625031. L. P. Kesselman, 205 La Verne Ave., Long Beach, California.

COUNTERWEIGHTED SIDEWALK ELEVATOR—For hoisting ashes or transfering merchandise from the sidewalk to a basement, may be entirely operated by one man, automatically locking against accidental movement. Patent 1628556. A. J. Rosell, 205 So. Oxford St., Brooklyn, N. Y.

MULTIPLE BENDING APPARATUS—Especially designed for the double bending of reinforcing rods used in cement structures, adjustable for varying the configuration of the bends. Patent 1628581. F. J. L. Dinkel, 817 Madison Ave., North Bergen, N. J.

TRY COCK—Which combines means with the appurtenances of a cock for preventing accidental separation of the valve control and parts connected herewith. Patent 1628566. W. E. Williams, 62 Front St., New York, N. Y.

PACKING RING.—Capable of contractile adjustment so that the ring works constantly on any or all points of the periphery of a rod. Patent 1631654. O. Stoffel, c/o Wm. Paterson, 311 35th St., Woocliff, West New York, N. J.

FABRIC-TESTING MACHINE.—With means for subjecting a piece of fabric to frictional action so that comparative tests as to wear-resisting qualities may be made. Patent 1632591. C. L. Dennis, 41 Union Square, New York, N. Y.

CHANGE-RETURNING DEVICE.—Operable by the pressure of a button indicating the number of units sold, and a second button indicating the amount of money deposited. Patent 1631326. L. B. Nordlund, 1095 Mission St., San Francisco, Calif.

COMBINED COAL STOKER AND BURNER.—Which affords facilities for feeding coal to the flame in a furnace at regular intervals ...

... Clair, 313 W. Granite St., Butte, Mont.

COIN-CONTROLLED LOCK.— For application to a door of a pay-as-you-enter compartment, when the compartment is in use the last coin inserted is visible. Patent 1633411. F. W. Kassler, 1343 Bayard Ave., St. Louis, Mo.

DITCHING MACHINE.—For cutting temporary irrigation ditches of any desired width ...

neously, and shaping the ditches to require contour. Patent 1632303. J. G. Lindema... 119 So. First St., Yakima, Wash.

DISPLAY SIGN AND METHOD OF PRODUCIN... THE SAME--The device may be used to dis... play pictures having the effect of movemen... either in part, or in whole, in show window or out of doors. Patent 1634174. S. Cornet... Reece, Kans.

COAL-SPOUT-OPERATING DEVICE—Which au... tomatically moves the down spout of a co... bunker through an oscellatory path ove... the feed trough of a boiler, furnace or th... like. Patent 1633914. G. M. Wutzler, 34 S... Elmwood Ave., Waukegan, Ill.

SAWMILL SETWORK—For use in connectio... with saw mill carriages, in adjusting th... knees or head blocks so that the saw wi...

Box 575, Fort Bragg, Calif.

SACKING, PACKING AND MIXING MACHINE—Wherein molasses is mixed with cotton seed hulls, or ground hay, during the packing operation, in such manner as to thoroughly incorporate the molasses and other material. Patent 1635-986. M. Gotten, 2283 Flarbert Ave., Memphis, Tenn.

LIQUID-MEASURING ATTACHMENT FOR TANKS—An attachment adapted for use in subterranean storage tanks by which the amount of liquid can be determined without the necessity of lowering measuring rods. Patent 1634608. J. E. Boegen, 1652 West Washington Blvd., Los Angeles, Calif.

LATHE CHUCK—In which the jaws of the chuck are moved simultaneously by a handle, giving greater gripping action than the ordinary

e, Ill.

e Movers and Their Accessories

ROTARY ENGINE—Including a plurality of arcuately shaped cylinders operated through oscillating arms, the arms in turn being controlled by oscillating levers carrying rol- s. Patent 1, S. D.

INTERNAL- ship propulsion, by the reaction of water contained within propelling tubes and flowing out of them under the action of compressed air. Patent 1661783. O. Angelini, c/o Barzano & Zanardo, 9 Via Due Marcelli, Rome, Italy.

CHARGE-FORMING DEVICE FOR INTERNAL COMBUSTION ENGINES.—Especially designed for use on motor vehicles, to increase the mileage per gallon of gasoline and decrease the formation of carbon in the engine. Patent 1631362. E. C. Colliard, Arcade, N. Y.

SPEED-REDUCTION MECHANISM.—Interposed between the main crank shaft and counter shaft of an internal combustion engine for controlling the operation of the rotary valve. Patent 1631739. A. J. Krause, 1408 E. 25 St., Cleveland, Ohio.

SPARK PLUG.—Which affords means for readily disassociating the parts for the purpose of cleaning and renewing, and reduces to a minimum the formation of carbon. Patent 1633435. E. N. and F. O. de Alcocer, c/o F. O. de Alcocer, 2418 Ellendale Place, Los Angeles, Calif.

ENGINE VALVE—Which is noiseless in operation, will eliminate tappets and springs, increase the efficiency of the engine, and eliminate the necessity of regrinding. Patent 1633694. A. E. Colchester, 59 King St., Dorchester, Mass.

ROTARY VALVE—With a packing ring diagonally arranged around the value cylinder and extending across the transverse plane of the engine parts to prevent leakage. Patent 1635963. C. H. Seifert. 165 Front St., Hempstead, L. I., N. Y.

Railways and their Accessories

LATERAL-MOTION BEARING FOR JOURNAL BOXES—A renewable railway journal box for supporting a lateral motion bearing of relatively soft material, so that the wheel may turn without appreciable friction. Patent 1635124. A. F. Hoegg, 217 Kline St., Weatherly, Pa.

OPERATING MECHANISM FOR DIRIGIBLE HEADLIGHTS—Which will automatically tilt the headlight of a locomotive to follow the roadway when rounding a curve, but will maintain the normal position on straight lines. Patent 1635097. T. P. Salley, 188 Clarkson Ave., Brooklyn, N. Y.

Pertaining to Recreation

BASEBALL GLOVE.—A fielder's glove, having flexible and automatically adjustable connection between the back portion of certain fingers, and the thumb and adjacent finger. Patent 1631735. P. and B. Kennedy, c/o Ken-Wel Sporting Goods Co., Gloversville, N. Y.

MOVABLE FEATURE FIGURE TOY.—Of the jack o' lantern type which has novel movable parts, the device can be held and operated by one hand. Patent 1632272. J. L. Centlivere, 311½ Second St., Laramie, Wyoming.

TOY.—Including a driving motor for actuating a wheel on which toy cars are suspended, and means for controlling the operation at a substantially uniform speed. Patent 1633496. C. E. Richardson, Simpsonville, S. C.

EXERCISING APPARATUS.—Comprising elastic members superposed in strip form so that they can be varied at will, and retained by a pair of hand grip members. Patent 1633124. R. H. Noe, 739 No. Auburndale, Memphis, Tenn.

CLOCK-DIAL GAME—Simulating the face of a clock with movable hands, and numbers from 1 to 12, the spaces including "nursery rhymes," for children learning the method of telling time. Patent 1634197. G. Kent, c/o John McKey, Newton Center, Mass.

PLAY-BALL COVERING—More particularly for inflated balls, composed of particolor zones, and forming a perfect sphere of supplemental gores of suitable material, such as rubberized fabric. Patent 1634146. B. L. Henry. Imperial Hotel, Broadway and 31st St., New York, N. Y.

Pertaining to Vehicles

CLOSURE-CAP LOCK.—Particularly useful in connection with tank trucks carrying inflammable material, means being provided for attaching a grounding lead to discharge static electricity from the tank. Patent 1633218. F. A. McDonald and F. G. Welke, 1538 Eleventh Ave., San Francisco, Calif.

ATTACHMENT OF MOTOR-VEHICLE ROAD SPRINGS—Appreciable to springs which are hingedly attached either direct to the vehicle frame or to the axle, or a bracket, as well as by means of a shackle. Patent 1634158. D. Robertson, c/o Collison & Co., 483 Collins St., Melbourne, Australia.

CUSHIONING MEANS FOR TILTABLE AUTOMOBILE SEATS—Adapted to support the rear end of "jump" seats of the coach type of automobile, the cushion may be easily removed or replaced. Patent 1633697. C. C. Davis and G. I. Clark. Box B. 4, c/o Edmars, West Palm Beach, Fla.

FLEXIBLE SPOTTER FOR REPAIRING TIRE CASINGS.—Which accommodates itself to the various contours presented in the work, and will bring about uniform even contact with the place to be repaired. Patent 1632651. E. A. Hubbard, 206 East Railroad Ave., Flagstaff, Arizona.

ATTACHMENT FOR TRACTORS.—Which per- the operator to steer with one foot, thus he is relieved of hand driving and permitted undivided attention to operating the plow. Patent 1632311. L. S. Phelps, R. F. D. No. 4, Box 13, Watseka, Ill.

DISPLAY DEVICE.—For projecting the license number upon the rear of a vehicle at night, using the vehicle body as a screen, conveniently attached to various types of cars. Patent 1632607. A. H. Kogge, 565 South Main St., Hightstown, N. J.

LOCK FOR AUTOMOBILES.—For opening and closing the ignition circuit, readily operated by an authorized person, while an unauthorized person would lock the same against functioning. Patent 1632576. R. Aifisi, 2243—83rd St., Brooklyn, N. Y.

LUBRICATING DEVICE FOR VEHICLE SPRINGS. —Which includes a reservoir and oil distributing units insertable between the leaves of a spring, and a conduit for automatically conducting oil. Patent 1630581. W. K. Riley, 525 Mortimer Ave., Huntington Park, Calif.

HYDRAULIC BRAKE.—Permitting a braking action to be obtained regardless of the direction of rotation of the rotor, and for permanently locking the rotor against rotation. Patent 1631800. F. Dotsch, Westmoreland Ave. & Intervale St., White Plains, N. Y.

POWER-TRANSMISSION MECHANISM FOR MOTOR VEHICLES.—Constructed so that two axels may be driven simultaneously in one direction or in opposite directions, or one section driven while the other remains stationary. Patent 1631837. G. M. Stone, Route 1, Griswold, Iowa.

TIRE BUILDING CORE.— Having a shape surface substantially triangular in cross s tion, which may be removed from the t with very little distorting effect. Patent B. DeMattia, c/o Munn, Anderson & Munn, 24 W. 40th St., New York, N

COMBINED LICENSE-PLATE AND IDENTIFICATION-CARD HOLDER.—Including the name of the owner, the make of car, etc., and will also serve to prevent the switching of the plate from one vehicle to another. Patent 1633414. A. G. Lorenz, 2403 Battery St., Little Rock, Ark.

DIRIGIBLE HEADLIGHT.—More particularly relating to an auxiliary headlamp or spot light for use in conjunction with the main stationary headlights, but swinging with the steering wheels. Patent 1633442. S. P. Foster, c/o John S. Wrinkle, Volunteer State Life Bldg., Chattanooga, Tenn.

BRAKING OF MOTOR AND OTHER VEHICLES—Which gives braking action its maximum intensity at high speed, prevents wedging of the wheels, and varies the action according to the type of wheel. Patent 1634186. P. Hallot, c/o Office Picard 97 Rue St. Lazare, Paris, France.

DETECTOMETER—Employing a dial and a movable hand for accurately indicating the temperature of the water within the radiator of an automobile. Patent 1633930. H. H. Dudley, 816 Southern R. R. Bldg., Cincinnati, Ohio.

Designs

DESIGN FOR A COMBINED ASH RECEIVER AND MATCH BOX.—Patent 72803. A. W. Rosen, 610 Broadway, New York, N. Y.

DESIGN FOR A DRESS.—Patent 72792. T. Davis, c/o Franklin Simon & Co., 38th St. & 5th Ave., New York, N. Y.

DESIGN FOR A SHOE.—The inventor has been granted three patents for ornamental designs for shoes. Patents 72789, 72790, and 72791. T. Davis, c/o Franklin Simon Co., 38th St. and 5th Ave., New York, N. Y.

DESIGN FOR A DRESS—Patent 73018. Maude Siegel, c/o Franklin Simon & Co., 38th St. & 5th Ave., New York, N. Y.

DESIGN FOR A CONTAINER FOR TABLE SERVICE—Patent 72936. P. L. Ebarle, 571A Natoma St., San Francisco, Calif.

DESIGN FOR AN ELECTRIC LAMP—Patent 72997. M. Gordon, 6019 Winthrop Ave., Chicago, Ill.

DESIGN FOR A DRESS—Patent 73011. M. Rochas, c/o David Cyrstal Inc., 1351 Broadway, New York, N. Y.

DESIGN FOR A DRESS—Patent 73001. R. Lemoine, c/o David Crystal Inc., 1351 Broadway, New York, N. Y.

DESIGN FOR A DRESS—Patent 73071. T. Davis, c/o Franklin Simon & Co., 5th Ave & 38th St., New York, N. Y.

DESIGN FOR GOBLET OR SIMILAR ARTICLE.—Patent 72968. E. C. Schrader, c/o Economy Glass Co., Morgantown, W. Va.

DESIGN FOR A VANITY CASE—Patent 72-941. M. C. de Botelho, c/o Products Bertie, 120 W. 42nd St., New York, N. Y.

DESIGN FOR A LAMP.—Patent 72950. J. T. Jarot, c/o Sun-Ray Lighting Products Co., 119 Lafayette St., New York, N. Y.

DESIGN FOR A GLOVE.—Patent Steinberger, c/o Steinberger I Ave., New York, N. Y.

DESIGN FOR A SMOKER'S STAND OR THE LIKE —Patent 72902. C. P. Knapp, 116 W. 39th St., New York, N. Y.

DESIGN FOR A PEDESTAL OR THE LIKE.—Patent 72910. E. T. Palmenberg, c/o J. R. Palmenberg's Sons, 63 W. 36th St., New York, N. Y.

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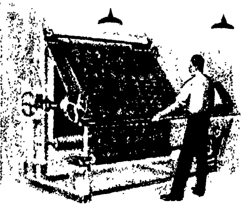

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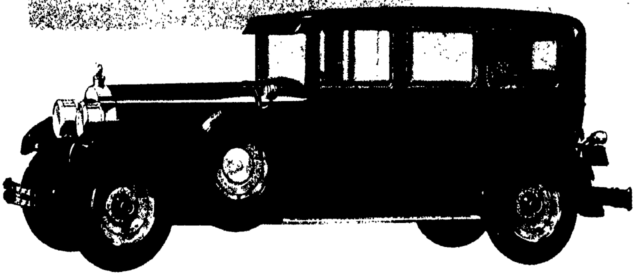

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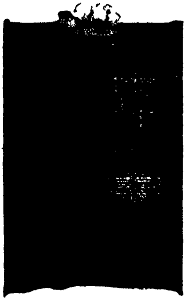

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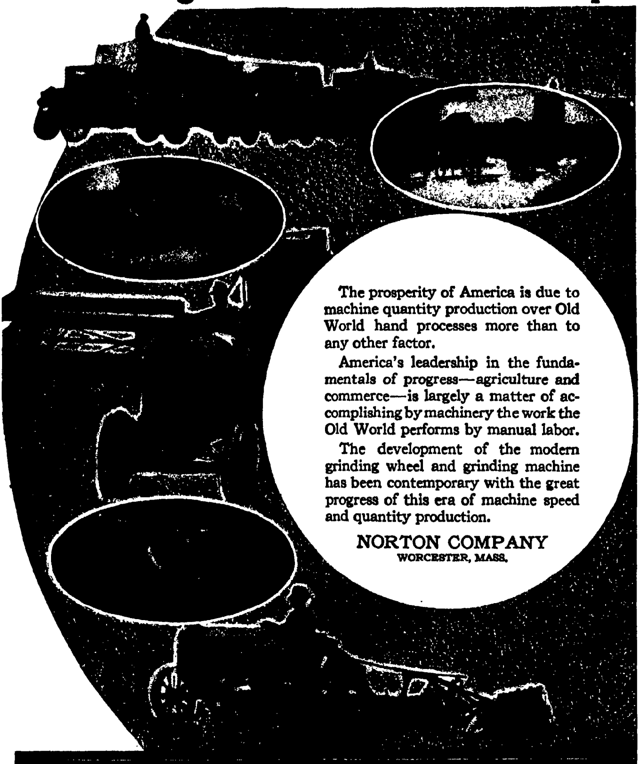
Grinding—American Leadership



The prosperity of America is due to machine quantity production over Old World hand processes more than to any other factor.

America's leadership in the fundamentals of progress—agriculture and commerce—is largely a matter of accomplishing by machinery the work the Old World performs by manual labor.

The development of the modern grinding wheel and grinding machine has been contemporary with the great progress of this era of machine speed and quantity production.

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SCIENTIFIC AMERICAN

November 1927 — *Edited by* ORSON D. MUNN — Eighty-third Year

Soap

WE have all met people who deride science. Scientists amuse them. Scientists do queer things and have such queer ideas. They make queer mistakes and—well they're just a little queer themselves, you know.

A man harangued one of our editors in that vein the other day, for half an hour, while both rode to New York on a commuters' train, crossed on a ferry, rode again in a subway. "The world would have been better off without it," he said, summing up against science. And almost in the same breath he "knocked" the subway for being slow.

That man lives in a house that without the benefits of science would have been a dimly-lighted hovel, he travels on trains made possible only by science, and, we noted, conversed about the enjoyment of his radio (no science, no radio), his car (ditto), mentioned making a 'phone call (science), wore glasses fitted by science, and was literally surrounded by the results of science, of whose benefits and significance he never took time to reckon. And there are lots more like him.

We wished that, for a day, we could have abolished the conquests of science and set him back in the Ages of Faith, the early Middle Ages. He couldn't even get his face clean. Soap is a product of science!

Bunk

WE received the other day a frantic letter of inquiry. "Is it true." we were apprehensively asked, "that the SCIENTIFIC AMERICAN has weakened in its former stand against the Electronic Reactions of Abrams and the technique of the Abrams Oscilloclast?"

Our reply was "No, we have not weakened—we are still unable to see the light." Unregenerate, we still regard the E. R. A. and the oscilloclast or 'Abrams Box' as bunk."

And, so to speak, "that's that."

Ham-and-eggs

ONCE again tradition has received the indorsement of science. After ten years' experiments in which 4000 albino rats have been fed, the Department of Agriculture reports that ham and eggs are an ideal food combination.

"The work has shown lean pork to be rich in vitamin B, but, on the other hand, low in the fat-soluble vitamin A," Ralph Hoagland, biochemist in the Bureau of Animal Industry, finds. "But when one considers that so many pork products are commonly eaten with eggs, which are rather low in vitamin B but rich in vitamin A, the nutritive value of the combination is apparent. Thus, meals containing ham and eggs, or bacon and eggs, furnish a liberal supply of these two important food elements, besides fat, protein, minerals and other desirable constituents."

CONTENTS

NOVEMBER 1927

DEPARTMENTS

Hair

HUMAN-HAIR imports from China have been increasing steadily since the first of the year. In January shipments were 21,384 pounds. By April they had more than doubled; 59,438 pounds valued at 20,110 dollars were received.

Does this mean our wives are going back to long hair and are about to use switches in the growing period? Have they been concealing something from us?

Egypt

THEY have been taking a census in Egypt. Its object is explained as follows: "The purpose of the old census was to learn how the people could better serve the state; that of the present census is to determine how the state may better serve the people."

Not only all of the dwelling houses, but even the tombs which shelter living humans have been canvassed and the police have rounded up the vagabond population. It is important. Egypt is facing a crisis in her history. She is within sight of complete exploitation of all lands that can be watered by the Nile, and she is turning from dependence upon agriculture to dependence upon industry and commerce. She must know how many mouths she has to feed and where the food is coming from.

Cover

THE subject of our cover this month is taken from the article, "Head Hunters of Burma," starting on page 393 of this issue. The painting was made from photographs of a Naga warrior and of a display of human skulls found before a native's hut. The warrior, as told in the article, has an elaborate head-dress of hornbill feathers and wears a "tail" from which depends long, dyed human hair. More details of the curious people of which this warrior is one, will be found in the article.

Among our Contributors

DR. PAUL R. HEYL

Dr. Heyl, author of the thought-provoking scientific-philosophical dialog on page 396, is a research physicist at the United States Bureau of Standards at Washington. His most recent achievement was reweighing the earth, whose avoirdupois was not precisely known. Despite preoccupation with much scientific research Dr. Heyl finds time to *think*—as those who read his article will agree.

PROF. H. AUSTIN TAYLOR

In the issue of last March we presented an article by Prof. Hugh S. Taylor of Princeton. We now publish one by Prof. H. Austin Taylor, Prof. Hugh S. Taylor's brother, of the Department of Chemistry at New York University. His subject is "phosphorescence." Both brothers understand well the art of popularizing science without resort to that abomination, "writing down" to the laymen readers.

Dr. Morris Fishbein

Each month Dr. Fishbein places before our readers a survey of the most timely and significant developments of medicine and surgery. As editor of the *Journal of the American Medical Association* (Chicago) he writes from a high vantage point: his own journal is read by two-thirds of America's doctors.

Harold J. Shepstone

This month we publish another of Mr. Shepstone's interesting articles—on the head-hunters of Burma. As a Fellow of the Royal Geographical Society he is in a strategic position to deal with travel, exploration and archeology. He has traveled widely and made a specialty of the things of which he writes.

W. E. Bailey

Mr. Bailey has embodied in a most engaging article the conclusions of a noted eye specialist and scientist concerning the origins of eyesight in animals, and that scientist has read Mr. Bailey's article in manuscript and given it his imprimatur. The theory in question is well supported by scientific observations.

D. H. Killeffer

Our chemistry editor is also Associate Editor of the technical publication, *Industrial and Engineering Chemistry* (New York). This is the official organ of the great American Chemical Society, of whose New York Section Mr. Killeffer is Chairman—a capacity in which he maintains close touch with chemistry.

Looking Ahead *with the Editor*

UNCANNY

A newly discovered method now being developed by Dr. Robert H. Gault, working under the aegis of the National Research Council, enables the totally deaf to learn to hear with their finger tips. To witness a group of these pupils taking in spoken words in this peculiar manner is most uncanny. In a forthcoming issue Dr. Gault will tell of his work.

RECONQUEST

A glacier plows down across a continent, scours away and obliterates every living thing in its path and later recedes. A thousand years afterwards Nature has put back the plants, shrubs and trees removed. A matter-of-fact happening, you say? Study it closely. Perhaps to your surprise it will become evident that Nature works in a remarkably systematic manner. How this occurs will be told.

LIGHTNING

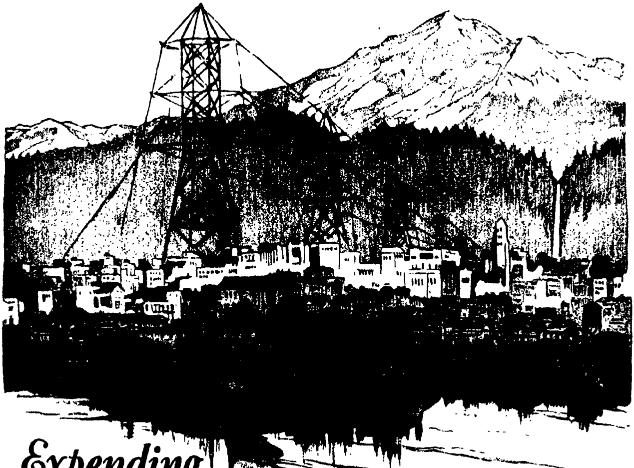
In an early issue an engineer on the staff of a great oil company will explain how a new method of lightning prevention has been developed to protect immense oil storage tanks. Can lightning actually be *prevented?* Obviously yes—for it is *being* prevented now. The inventor will describe his method.

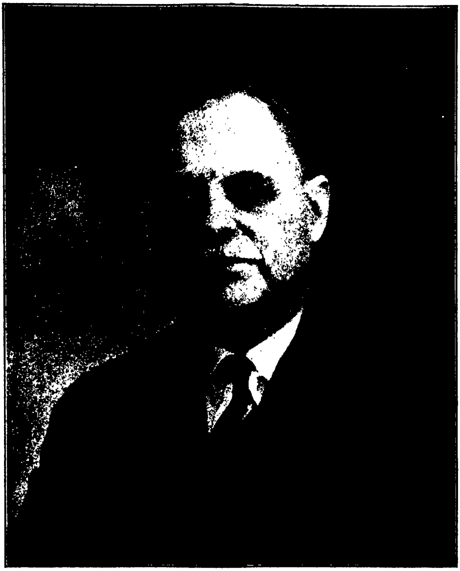
ANCIENT

The interior of the great Arabian Desert remains almost unexplored. A noted archeologist will narrate the story of a journey across recently made, in which evidences of man of 20,000 years ago were actually found lying on top of the ground, waiting to be picked up. Here is an article which will make you want to organize your own expedition!

PAINLESS?

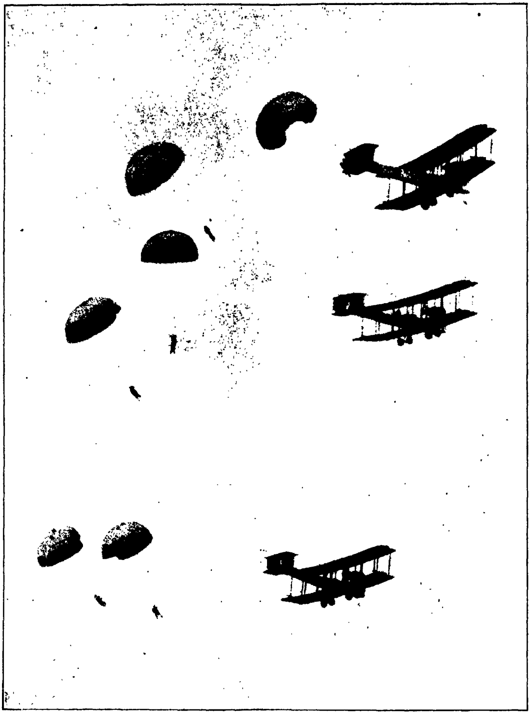
Do insects feel pain, like other animals? When injured they squirm as if they did, yet one naturalist says they feel only discomfort. Some remarkably interesting experiments have been performed, and a few will be described soon.





PROFESSOR ELIHU THOMSON

Dr. Thomson, an electrician, is Director of the well-known Thomson Laboratory of the General Electric Company at Lynn, Massachusetts. During his many years of work in the electric lighting and power field he has made more than 500 inventions. Among these perhaps the most notable is electric welding. He has been honored with many medals and by election to membership in American and foreign scientific societies, and is a member of the National Research Council and the National Academy of Science. For a time he was acting President of the famous Massachusetts Institute of Technology ("Boston Tech"). His life work has spanned the vast development of the electrical industry. He is still actively engaged in research



Wide World

Six At a Time!—English Parachute Jumpers

At a recent air carnival held at Heddon air-field, England, a spectacular feat that was not on the program was performed. Because of the impossibility of being sure that conditions would be right for the unusual attempt that was secretly planned, word of it was not released to the public until the planes had taken off. Then the loud-speakers of the public-address system, through which announcements were made, suddenly informed the crowd that they would shortly witness a most unique display of parachute jumping. Three Vickers Vimy planes were in the air, and the spectators could see a tiny figure crouching on each wing-tip of each of the planes. These were parachute jumpers, six in all, clinging to the upright struts that brace the wings. At a given signal they all pulled the rings that released the parachutes and were pulled off the wings. Each of the parachutes opened perfectly, and the six aviators floated safely to the ground.

IMBUED WITH THE SPIRIT OF THE DANCE

Two native girls dancing to the rhythm of a chant by a group of the men

Head Hunters of Burma

How England, at Considerable Cost and Peril, is Obtaining the Freedom of Thousands of Slaves from the Tribes in the Naga Hills

By HAROLD J. SHEPSTONE, F. R. G. S.

An Ao Warrior

SLAVERY and human sacrifices within sight of the British flag sounds a little startling. Yet last summer no fewer than 3445 slaves were given their liberty in the Naga Hills at a cost to the Burma Government of just over 5000 dollars. This season almost as many slaves have been released by the various columns now operating in these mountain fastnesses.

Although on the whole, success has attended Captain Barnard's present expedition, he is nevertheless finding the work exceedingly dangerous and trying. One of his officers, Captain West, in charge of one of the emancipation parties, has been killed, as well as two of his Gurkha escort. The fact is that the tribes inhabiting these mountains are not only very warlike, but are inclined to resent the intrusion of any strangers.

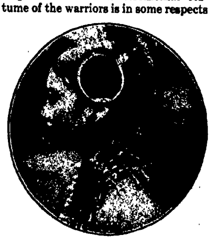
The Naga Hills constitute one of the most curious frontiers in the world. The region consists of great mountain ranges, towering 10,000 feet and more in height, stretching for a distance of some 500 miles, and varying from a few miles to nearly 100 miles in width. On one side lies the valley of the Chidwin and Irrawaddy. Although these mountains lie between two fertile provinces, with their railroads, roads and steamer services, they are as yet largely unexplored. Here dwell the Nagas, among the most primitive and picturesque of savage tribes to be found anywhere in any region in the world.

In this mountainous territory, which is very difficult to penetrate, there are fully a score of different tribes. Although they vary considerably in physique and temperament and in manners and costumes, they are all very warlike. The villages in which they dwell are invariably built on the very summits of the spurs and ranges, and ingeniously guarded against surprise attack.

THE villages are surrounded by a thick, impenetrable wall of living cane, with terrible reversed thorns. This fence in turn is often further strengthened by a ditch, while the approach to a village is by means of a tunnel under the cane, the latter being tied up by stakes. On the approach of an enemy the cane is allowed to fall and block the tunnel. Should an invader get through this, he would find himself confronted by a ditch from which the plank had been removed, bristling with *panjis*—sharp-pointed bamboo spikes that will pierce a man's foot.

It was because of the head-hunting propensities of these warlike hill tribes that the Indian Government, to protect the workers in the plains from raids, took over the administration of the Naga Hills. One officer is stationed at Kohima, in Angami territory and another at Nokokchung, among the Aos. They are administering only a portion of the territory, the idea being that the government should extend its influence gradually by peaceful penetration. In the unadministered areas, however, head-hunting and human sacrifices are still indulged in and the aim of the government is to endeavor to put down these practices by sending expeditions into these partially explored regions to buy slaves and set them at liberty.

All travelers are agreed that the Nagas are among the most picturesque savages in the world. They are great lovers of feathers, ornaments and bright colours. The ceremonial costume of the warriors is in some respects



AN AO WOMAN

The characteristic head rings are of brass, while the necklaces are composed of cornelian beads and white metal ornaments

magnificent. They wear head-dresses of hornbill feathers which are so adjusted that they readily turn in the wind, as otherwise they would break. Around their bodies are baldrics, or scarfs, embroidered with scarlet hair, from which depend aprons of cloth completely covered with cowrie shells.

Their most characteristic ornament, perhaps, is a tail of human hair, also dyed scarlet. In the old days the hair was taken from the head of a dead enemy, but in the administrated areas girls with fine hair sell their tresses for this purpose and grow another crop. The warriors' weapons consist of a spear and a *dao*, the latter being a kind of chopper-shaped axe. With it a Naga can slay an enemy, cut up a chicken, fell a forest tree, pare down the finest strip of cane, dig a hole for a post or cut a thorn out of his foot.

THE FAMILY BARBER

A native father cutting his son's hair. The hair is wetted and then shaved with a piece of broken metal

Striking features of the dress of the women are their head ornaments of brass rings and ropes of cornelian and conchshell beads. A Naga woman will take as long in adjusting her head ornaments as a western lady will in putting on her hat. Their ears are pierced and all sorts of earrings are favored—pieces of crystal rock, bunches of bright red chillies and the feathers of some bird. Their skirts are made of native cloth and in some tribes they are beautifully ornamented with white, red and dark blue bands.

A CHANG CHIEFTAIN

The boar tusks and the shells depending from his ears denote that he has taken heads. He is sipping rice beer through a tube, a characteristic Chang habit

By nature all Nagas are head-hunters and those chiefs in the administered areas, where the taking of these ghastly trophies is not allowed, bemoan that fact and speak with disgust of the prospect of "dying like cows" in their own beds.

Now, a Naga takes heads for two main reasons. He wishes to bring home tangible proof that he has slain his enemy, and he also wishes to obtain the soul of his enemy, so that the soul-power of his village may be re-enforced and its prosperity and fertility increased. The heads taken are those of a rival tribe.

Occasionally, slaves are sacrificed, although here it is difficult to learn exactly what happens, as slavery is not permitted in administered territory. So far as one is able to discover, the victim is given special food and made a great fuss of before the fateful day. They apologise to him for any inconvenience he will be caused, and point out the great honor that is being done to him in sacrificing him to the harvest gods. He is given copious draughts of *madhu*, or rice beer, and there is no doubt that he is in a state of stupor when his time for departing this world arrives.

SOME tribes expose the heads they take on the top of bamboo poles; others place them on the branches of the sacred tree of the villages, and other tribes keep them in the chief's house, or in the *morungs* or bachelors' houses, or under sacred stones. Occasionally one finds a human head with a dog's skull above it. This is done in case the man's relatives should ask him in dreams who killed him. When he replies, the dog barks and thus drowns his answer!

The reverence in which the human head is held by these primitive people is most extraordinary. The Konyaks, a particularly warlike tribe, give special treatment to the head after ordinary death, believing that it contains a man's soul. It is taken from the body, cleaned and brought into the house, where it is visited by friends of the deceased, who bring gifts and express their grief. The head of a young buck will be visited by the girls among whom he was popular; they will sob and lay before the head little quids of betel-nut, reminding the departed of the happy days they had together.

One of the administrative officers of the Naga Hills, Mr. J. P. Mills, related to the writer how he assisted a deposed chief of the Chang tribe in regaining his throne. A few months later he received a present from him—a human head which the chief declared he had taken with his own hands; and was quite grieved when the present was refused.

Every village is independent and governs itself. Some are ruled by chiefs and others by a body of councillors. The appointment of the latter and the varied duties they have to perform are all rigidly prescribed. When the time comes for the councillors to vacate office there is invariably a great deal of argument, the office-holders contending that their time is not up and the younger men insisting that it is.

TO the westerner the methods of the councillors may appear a little strange, but they are effective. A fine for breaking the law may be so many baskets of rice or a pig, and the councillors have a happy knack of partaking of the fine first and finding the culprit afterwards. For example, one man complained of damage to his bamboo clump. The councillors gave orders that the depredations were to cease. But this proved of no avail; so they levied a fine of a pig on the unknown culprit, commandeered an animal and ate it. The villagers were informed that if they found the culprit he would be made to pay for it, otherwise the value of the pig would be added to the taxes. This had the effect of turning the whole village to detective work, and it was not long before the offender was brought to justice.

READY TO GO

Another view of an Ao warrior, this time clothed in full regalia for the war-path. Note the dao which he is carrying

A WEDDING DANCE

Among the savage tribes of the hinterland of Burma, dancing has been developed to a fine art. Here we have an example of it. The marriage customs are rather peculiar, in that the man buys his wife, or else works for her father for a certain period of time in order to pay for her. Generally speaking, the natives are monogamous, but the richer men and the chiefs occasionally have as many as 50 or 60 wives to support

With but few exceptions, every Naga village boasts of its *morung* or bachelors' house. This is the barracks or guard-house of the village in which the boys and unmarried men sleep and which the men use as their clubhouse. Boys enter the *morungs* when about ten years of age, and for the first three years act as "fags" for the older boys, becoming "bloods" at the end of that time as a new age-group of boys take their place. A boy remains in his age-group till he dies, and it is by this system of age-groups that various communal duties are carried out. The young bucks will be found toiling in the fields, doing the hardest work and taking the greatest risk. At the village gate there may be an old man weeding a little patch—the last member, perhaps, of his group. He is allotted the lightest task.

In some tribes both men and women resort to tattooing. Among the Aos, for example, the women are tattooed on the chin, throat, chest, arms and legs, the patterns differing according to the language, group or clan to which she belongs. The tattooing is done before marriage by an old woman

A SEMA GIRL

Apart from the usual ornaments, she wears a band encircling her hair, showing that she is betrothed. Note the native-made cloth that she is wearing as a kilt

skilled in the art, the required pattern being beaten into the skin with a little mallet of thorns.

Generally speaking, girls marry between the ages of 14 and 18 and boys between 17 and 22. The marriage customs vary considerably in the different tribes. But a Naga either buys or works for his wife. In the former it may amount to so many baskets of rice, or a number of *daos* and other weapons; while in the latter case he works in the house or in the fields of his father-in-law for a stated period, generally a year. While, as a rule, Nagas have but one wife, wealthy men and chiefs in certain tribes have quite a large number, the *angs* having as many as 50 or 60. The chiefs of the Konyaks are regarded as sacred beings and wield immense power. A village may not shed the blood of its *ang*, however oppressive he may be; but cases are reported of the difficulty being overcome by throwing him over a cliff. A curious custom among the men of this tribe is to draw in the waist with cane belts.

THE staple food of these people is rice, to which chillies are added as a relish, as they like their curry hot. They also cultivate millet and "Job's tears" and rear and hunt cattle, as they are great meat-eaters. Woe betide the elephant or tiger that damages their crops for he is hunted remorselessly until he is killed, often with the most primitive of weapons. A Naga never drinks water if he can help it—always *madhu*, a kind of rice beer. If he goes down to the river to fish he takes his beer with him.

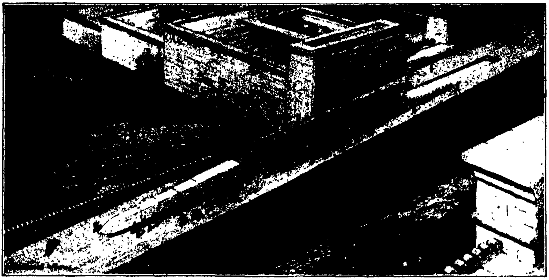
The American Baptists have a mission station in the Naga Hills and their great stumbling block in converting these people is over the question of prohibition. I heard of a Naga, a very fine type of fellow, who joined and rejoined the church six times in two years. He could not give up his *madhu*. Another endeavored to get over the difficulty by keeping up two establishments, on the plea that while residing in one he was at liberty to indulge in his old habits, but in the other he lived as a Christian.

The religion of the Nagas is animism, the worship of spirits. It is bound up with every act they do. The sowing and reaping of crops, the building of a house, the taking of a wife and many other acts are initiated by sacrifice, the smaller victims usually being chickens and the larger ones pigs. Apart from these sacrifices to spirits, feasts of merit are given; they are, as it were, ceremonial public banquets. It is the aim of rich men to perform the whole series, beginning with pigs and going on to cattle and *mithan*, or domesticated bison. He who has accomplished the full series may wear special ornaments, build his house in a particular way, and in some tribes set up a stone monolith.

To the ethnologist, the Nagas, with their strange manners and customs, and their no doubt close association by migration with the natives of Borneo and some of the South Sea islanders, present an intensely interesting study. As already stated, they are not only very warlike, but absolutely fearless, have a mania for taking heads, and firmly believe that the success of the harvest depends upon their offering up a human being. The latter is often a slave, of which there are hundreds in the unadministered areas. Hence the attempt by the Burmese Government to penetrate into these regions inhabited by the slave owners, and give the slaves their liberty by purchase.

A SOUTHERN SANGTAM COUPLE

In the background is their house. Parts of the country in which they live were hardly known to civilization ten years ago



Courtesy of the Illustrated London News

AN ANCIENT EGYPTIAN "90 HORSEPOWER TRACTOR"

Muscles Built the Pyramids

Human Muscles are More Efficient than the Best Steam Engines. An Electrical Theory of Muscular Action

"I'VE been spending the winter in Egypt," remarked one of a group of men in the smoking room of an Atlantic steamer. "Wonderful country—but its interest lies mainly in its past. The pyramids are marvels of ancient engineering."

"As an engineer by profession," said a second man, "I must protest that statement."

The other members of the group, who had given but languid attention to the conversation up to this time, showed signs of interest.

"We engineers," continued the speaker, seeing all eyes fixed inquiringly on him, "must justify the time and money spent on our training by doing things more expeditiously and economically than the untrained man. The French call us *ingénieurs*—"ingenious fellows." Now if there was anything really ingenious involved in the laying up of those masses of stone, I don't know of it. Those old fellows undoubtedly used the inclined plane to raise their blocks to position, but they are entitled to no particular credit for that. That device has been a matter of common knowledge ever since the first squirrel ran up a slanting tree."

"That's true," said the Egyptian tourist. "They didn't even use rollers. I saw one of their old pictures, showing a crowd of over a hundred slaves dragging a large stone statue mounted on a sledge. There was a man pouring something, probably oil or grease, on the ground in front of the sledge, and another man clapping his hands to mark time for the slaves to heave. And both these lazy beggars were riding on the sledge!"

"Yes," said the engineer. "That's exactly my point. The Pharaohs of that period had unlimited slave labor at their disposal. It was only a question of paying enough taskmasters and providing whips for them. The rest of the equipment was main strength and brute force."

"COULD you do the same work more efficiently today?" The question came from a man who had taken no part in the conversation before, and of whom little had been learned during the voyage, except that he was a physician. The engineer seemed rather irritated by the question and replied half contemptuously.

"Of course you know how such a job would be done now-a-days: a few portable steam engines with cranes and derricks, and those blocks would be slung into place in a jiffy. I don't know how long it took those old chaps to build one of those pyramids—the King's life-time, I've heard; but however long it took them, I'd take a contract to lay up the cut stone in less time with not over 50 men provided with modern facilities."

The tourist whistled softly.

"Better go a little slowly," said he. "At the Second Pyramid they showed us the workmen's barracks, still standing after 6000 years. They must have housed at least 4000 men."

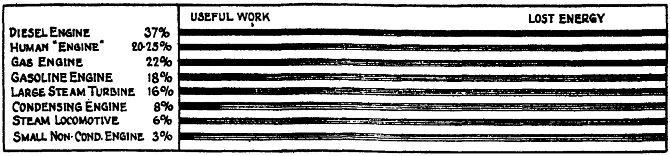
"Only 4000?" said the engineer. "Well, I suppose some allowance must be made for ancient brutality as against modern humanity. Today we'd hardly drive a man till he dropped. No, sir—we've made progress all along the line." And he glared rather defiantly at the doubting Thomas, who, after a brief pause, returned to the attack.

"Perhaps you, as an engineer, can tell us just what is the efficiency of a steam-engine?"

The engineer started to speak, but instead put his pipe in his mouth and puffed at it for some moments, eyeing the speaker thoughtfully. When he finally spoke it was in a tone of more respect than he had previously used.

"Well, these figures are things which we do not usually carry in our heads. We can always find them in the engineering handbooks. But I must say that the efficiency of a steam engine is not what we would like to have it."

"I happen to remember the figures," said the physician. "You will doubtless recall them. Taking the energy in the coal as a basis, the fraction of it converted into mechanical work may be anything from 5 to 20 percent. The non-condensing engines that dis-



WHERE DOES THE HUMAN "ENGINE" STAND WITH OTHER ENGINES IN MECHANICAL EFFICIENCY?

The human body is a more efficient engine than a steam turbine. What the non-human engine lacks in brains. These enable man to create engines which far excel his own body in total volume of energy. But until certain fundamental inventions had been made, brains counted for little

charge their steam into the air, such as portable engines and locomotives, give the lowest figures. Those engines that condense the exhaust steam and return the hot water to the boiler are the most efficient. But the most perfect engine in existence today wastes more than it produces."

"That is true," said the engineer. "But what about the human machine? We take in a certain number of calories in our food, just like the thermal units in the coal, and we convert some of it into work. I'll confess I don't know how much—but perhaps you do?"

"In this respect the performance of the human body exceeds that of the best compound condensing engine, and is comparable with that of the gas engine—from 20 to 25 percent efficiency."

The engineer whistled in his turn. After some time he said slowly and thoughtfully:

"Well, then—if old Pharaoh had freed his slaves—turned them loose to earn their own living, and had burned all the corn that he would otherwise have fed them, under the boilers of such engines as would be used today on outside work—he wouldn't have had fuel enough to finish the job!"

The physician shook his head.

"He would probably have had more than enough. We haven't all the packing out of the case. When the whistle blows for the day, the steam engine consumes no more fuel till the next morning; but the case is different with a man. He is like an engine with a low fire kept under its boiler all night and over all holidays. A man never stops working. During so-called 'working hours' he does only a little more than at other times. Even when he lies asleep his muscles of respiration are active and his heart-pump is going. In addition, his bodily temperature must be kept up. All this may require, in the 24 hours of the day, as much fuel as is utilized in the performance of what is usually called a day's labor."

"IT seems, then," said the engineer, smiling, "that simply on considerations of mechanical efficiency, old Pharaoh did better than we could do today, though he did take an intolerable time about it."

"Yes," said the physician. "The human body is a fairly efficient machine, though not very powerful."

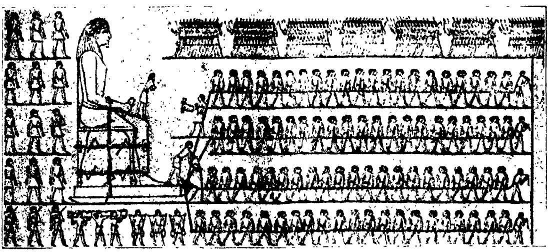
"There's something strange about that," said the engineer, after a pause. "A steam engine requires a boiler, and a condenser. In some cases the condenser is merely the open air. Between the boiler and the condenser there is usually a difference of temperature of a couple of hundred degrees Fahrenheit, and it is this difference of temperature that determines the efficiency of the engine. If we reduce it, the efficiency decreases; we therefore try to increase it as much as possible by using superheated steam in a high pressure boiler. But of course there can be nothing like that difference of temperature in the human body."

"No," said the physician. "A general increase or decrease of more than a very few degrees would soon be fatal; and any small portion of the body heated for any length of time to the boiling point of water would have its life destroyed."

"That's where the strange point comes in," went on the engineer. "With the greatest difference of temperature we can handle we cannot equal the efficiency reached by Nature, using no difference at all. And it's the only way we know of doing it. Are we on the wrong track? Why not imitate Nature's process?"

"Because we do not yet know enough about it. I agree with you that it would be worth while to imitate it. I would even go so far as to say that it is quite possible that we might improve on it. But we must know more about it first."

"But do you physicians know nothing about it?"



ANCIENT EGYPTIAN DEPICTION OF SLAVES HAULING A STATUE

At top, soldier guards. At left, reliefs of men. Lower left-hand corner, taskmasters. At their right, men carrying implements. Next, men carrying grease. C man pouring out grease. And they didn't ev

"Very little, I regret to say."

"Tell us that little, doctor; don't be afraid to talk shop. This is getting interesting."

"Well, it will not take long to tell what we know. Since the mechanical work of the body is done by the muscles, it is in their ultimate structure that we naturally look for the answer to the puzzle. This ultimate structure is not hard to make out. A muscle is made up of thousands of tiny fibers, just as a hawser is made up of filaments that you might snap in your fingers. The little fibers making up a muscle may be an inch or so long and a few thousandths of an inch in diameter. Each fiber possesses the property of contracting when stimulated, and the sum of thousands of such feeble contractions makes up the force of the muscle."

"These fibers are something like rubber bands, I suppose," said the tourist.

"No, that is just what they are not. They are little bags containing a watery solution and some jelly-like material."

"That's curious," said the engineer. "Water is just about incompressible. That's why we use it in the hydraulic How can such a fiber contract?"

"It doesn't contract at all, in the sense of diminishing in volume. It shortens and thickens at the center, apparently trying to become globular; but this change of shape takes place without the slightest change in volume."

"Is there any known principle which would explain this action?"

"Yes, there is one—surface tension."

The tourist looked blank, but the engineer nodded.

"SURE enough—that would explain it. Just as a drop of water on a dusty floor takes a spherical shape instead of flattening out. You see," he continued, turning to the tourist, "every liquid acts as though it was encased in a stretched elastic skin, which is always trying to squeeze it into a spherical shape. If there is much liquid, its weight flattens it out, but if there is only a little the surface tension overpowers the weight, and we have a dew drop. But," he went on, addressing the physician, "what holds surface tension in abeyance in a relaxed muscle?"

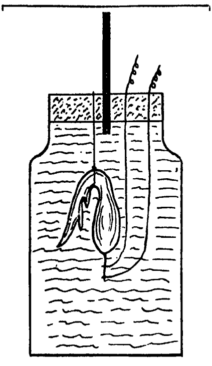
"It must be that the surface tension changes. It is known that muscular action is accompanied by a chemical change in the contents of the fiber. The process is probably like this: the relaxed muscle contains a solution with a weak surface tension. Upon nervous stimulation (don't ask me how) a chemical reaction is set up, and the resulting solution has a greater surface tension. In consequence, the fiber shortens and thickens."

"Then," said the engineer, "when the muscle relaxes, the reaction must reverse itself."

The physician nodded.

"But contraction is sometimes very rapid, and relaxation equally rapid. And, as I remember my chemistry, a reaction that takes place rapidly and easily is usually slow and difficult of reversal."

"That is the weak point of the theory," said the physician. "But we have nothing better to offer. It certainly appears that a change in surface tension must be the fundamental reason for the shortening of a muscle; the absence of any change in volume points definitely that way."



FROG'S LEG EXPERIMENT

The nerve is connected to wires, current contracts muscle, but water is not thereby raised in small tube at top; showing that muscle has not altered in volume

"What else happens when a muscle contracts?" asked the engineer.

"A little heat is produced, and some electricity."

"Electricity? Are we built like the electric eels?"

"It seems so, to a slight extent, at any rate. Why not? All Nature is one."

"Is this electricity an after-effect?"

"No, it seems to occur simultaneously with the contraction, or even, as some have claimed, a minute fraction of a second earlier."

"When I was a boy," said the engineer, reflectively, "I once took hold of the handles of a medical battery—and I couldn't let go. They had to turn it off first. There was a case where the electric current not only accompanied muscular action but caused it."

"Yes," said the physician. "We commonly use electricity to stimulate muscular action in our laboratory experiments."

The engineer puffed silently at his pipe for a few moments.

"Look here," he said suddenly. "Aren't you doctors on the wrong track—haven't you got the cart before the horse?"

"How so?"

"This generation of electricity you speak of—what useful purpose does it serve?"

The physician shrugged his shoulders. "No one knows."

"But it must play some important part in the action?"

'Yes," said the physician, thoughtful in his turn. "Otherwise it would be a waste—a mere gesture on Nature's part. And man is the product of so many ages of evolution and survival of the fittest that lost motion of this kind should have been pretty well eliminated. But what's your idea?"

"SIMPLY this: the electric current is the real reason why the muscle contracts; and it relaxes when the electricity is turned off."

The physician in his turn looked keenly at the engineer.

"In that case, electricity should produce a change in the surface tension of a liquid conductor."

"Yes," said the engineer. "It does. The fact was discovered by Faraday."

This was evidently a new idea to the physician. He was silent for a few moments. Then he said:

"According to your idea, the muscular contraction should be proportional to the strength of the current applied to it?"

The engineer nodded.

"Well," said the physician, "experiment does not support that. It seems clearly made out that a muscle fiber indulges in no halfway measures. Either it contracts to its full extent or not at all. We call this the 'all-or-none' law."

"But certainly a muscle can act by intermediate stages?"

"We explain that by supposing that only a part of the fibers are stimulated."

"But why not suppose that only part of the fibers are affected by the current? Isn't it as broad as it is long?"

The physician admitted that it was.

"Well," said the engineer, glancing at the clock and rising, "it's nearly time for lunch. I'm indebted to you for a pleasant and interesting morning, doctor. I expected to be horribly bored, as is usual when one is on these voyages."

"Yes," said the physician, with a twinkle in his eye. "I think we have both learned the advantage of looking at our own work through another's eyes."

Motor-bus Transportation De Luxe

Luxurious Appointments Contribute to Traveler's Comfort

THE BUS AS IT APPEARS ON THE HIGHWAY

With its long wheel base, large pneumatic tires (double ones on the rear wheels), and heavily upholstered seats, this newly designed addition to a western transportation system presents solid comfort to the traveling public which uses the bus

THE "PILOT HOUSE"

So that he may have a full view of the road, even in heavy traffic, the bus driver is located in an elevated glass enclosure

THE RADIO EQUIPMENT

Built into the side of the bus is a complete radio receiver. The cone type loud-speakers are located in the ceiling of the body

LUNCH IS SERVED

Part of the equipment of this new bus is a complete "galley" from which meals are served. Notice the grill-work in the ceiling. This covers the cone type of loud-speaker used with the radio set. The latter is installed in the side of the bus

TRAVELERS from Los Angeles to San Francisco may now go by motor bus, and still have all of the comforts of the ultra-modern railroad train, with possibly a few others added. The upper illustration on this page shows a side view of one of the new busses that makes the trip. One of the most unique features, at first glance, is the position of the driver. His seat is elevated and the enclosure that protects him from the elements has glass on all sides. Thus he has clear vision to all points, and being elevated, can watch other cars and exercise more care and judgment when in traffic. Within the bus, every desire of the traveler has been taken into account. Lunches may be obtained from the buffet, and the radio may be turned on when entertainment is desired. There are two decks on the bus, seats on either one affording the passengers ample view of the surrounding country. It is busses of this kind that should contribute largely to the opening to the public of territory in the west that is not efficiently served by rail. Busses that are safe, comfortable and fast will naturally tend to draw rapidly increasing patronage to them.

OUR POINT OF VIEW

NAVY DAY

NAVY DAY was instituted for the purpose of bringing before the American people the importance of the United States Navy as the first line of defense of their country. One of the outstanding facts of United States history is that whenever war has come upon us, the American people have been quick, though late, to realize the vital importance of a navy in our scheme of defense, and that, as soon as the war was over, the great lesson has been forgotten, and the navy has suffered neglect and fallen to a very low level of strength and efficiency. This happened after the War of the Revolution, after the War of 1812, and notably after the great Civil War.

The vital importance of a powerful navy in a war waged against an enemy possessing an extended coastline, was never more clearly emphasized than in the Civil War; for it was only when the hastily built fleet of the Federal Government became powerful enough to enforce an absolute blockade of the Southern states, that the Northern armies were able to crush the heroic resistance of the enemy. But apparently the lesson thus taught was quickly forgotten. The great fleet was quickly demobilized; no effort was made to keep abreast of modern naval development; and our navy sank to such a low ebb that 20 years later, our flag was represented on the seven seas by a mere handful of old and rapidly deteriorating wooden ships.

It seems to have been overlooked that the Washington Treaty of Limitation has effectually prevented any such neglect; for by that treaty we are held up to a parity with the British fleet. As matters now stand, the prevention of any such deterioration of our navy as occurred after previous wars depends upon the willingness of the American people and their Congress to maintain our navy in the front rank assigned to it by the Washington Congress.

If the country thus does its duty by the navy, the only way in which we could lose our position would be by the determination of Great Britain to break away from the treaty and build up her fleet independently of treaty requirements. But at the late Geneva conference British representatives reiterated over and over again their wish to abide by the treaty and maintain their fleet only at parity with our own.

MERCHANT MARINE AND THE NAVY

FEW people realize that the defense of our coast-wise, sea-going commerce is fully as big a problem as the protection of our sea-borne commerce with foreign nations. So much attention has been directed to the latter problem that the importance of protecting coast-line shipping is in danger of being overlooked. It will be a surprise to many to learn that the ocean-going, coast-wise trade of the United States is of equal size and value to the entire ocean-borne foreign commerce of the country in ordinary years.

Our freight carried by ocean coastwise shipping in 1925, excluding Great Lakes traffic, amounted to over 91,000,000 tons, whereas our ocean-going foreign trade in the same year was less than 90,000,000 tons. This important trade, moreover, is so vast that no considerable part of it could be taken over by the railroads during a war.

Our rail transportation facilities were taxed to capacity during the World War, which hardly inconvenienced coastwise shipping. Since the war, the population of the United States has increased 10 percent, whereas our railroad mileage has increased not at all. The enlarged freight and passenger traffic of the past ten years has been absorbed by the greater efficiency in the operation of our railroads and by motor transportation. These agencies, however, could not assume, in an emergency, an additional burden of 90,000,000 tons of long-haul freight. Evidently an efficient navy is necessary to insure the uninterrupted flow of this coast-wise trade, to say nothing of its other multifarious duties throughout the seven seas. Regarded in this light, the navy may be looked upon as an insurance of one of the greatest arteries through which the lifeblood of our vast industrial and commercial interests flows.

Destroying Faith in Aviation

BEFORE people will take to the air in sufficient numbers to render commercial aviation successful, they must be convinced that air travel is safe. This is an absolutely fundamental condition. Hence the recent epidemic of ocean flights with its loss of over two score lives and a dozen machines, has struck a sad blow at commercial aviation. The flight of Lindbergh gave a wonderful impetus to the art, the effect of which has been sadly blighted by the hasty ven- [illegible] of [illegible] ...nished [illegible]

Says Colonel Lindbergh: "Regular trans-oceanic travel by air is no more practical today than transcontinental air lines were a decade and a half ago. . . . .The pioneering is over, but the perfecting is yet to be done."

GOOD FOR FIFTY YEARS

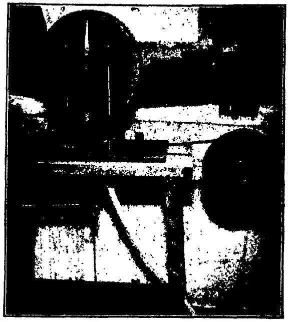
VERY subtle is the technique of the propagandist. More often than not he seeks to gain his point by devious ways. Thus, the advocates of the construction of an American deep-sea canal at Nicaragua are endeavoring to pave the way by representing that the Panama Canal is approaching the limit of its capacity. John F. Stephens, the distinguished engineer who preceded Colonel Goethals at Panama and organized the methods of excavation which effectually hastened the completion of the work, recently dealt a death blow to this propaganda at an address delivered at the Annual Convention of the American Society of Civil Engineers.

He proved by unanswerable statistics that, after future enlargements, the canal will "have ample capacity for all transits for the next 50 years and perhaps longer." Here are the figures: Although the canal is operated only during daylight hours; on January 17, 1924, a total of 57 vessels made the transit. The Soo Canal, which is closed for four months in the winter, passed in 1926, an average of 90 vessels per day. If these locks should work the entire year they would pass 32,860 vessels, or about 134,000,000 tons. The Panama Canal passed 26,836,241 tons in 1926. Since the Soo Canal could pass 100,000,000 tons yearly, if not ice-bound for four and one half months, what could the Panama Canal, with practically the same facilities as the Soo, pass in twelve uninterrupted months of operation? The maximum number of transits at Panama in one month was 611 ships in March, 1927. This represents an average of 19.7 per day, which is not over 40 percent of its capacity.

With wise provision for the future, the locks at Panama were so located and built that, when the need arises, a third set of locks can readily be added alongside the present locks. Nor need there be any anxiety as to future water supply, which can be greatly increased by the construction of a large dam at Alhajuela, a few miles above the point at which the Chagres River enters Gatun Lake. With the new locks added whenever they become necessary, and with day-and-night-operation, which is perfectly feasible, the Panama Canal, so far as human foresight can determine, will serve its purpose adequately for another half century.

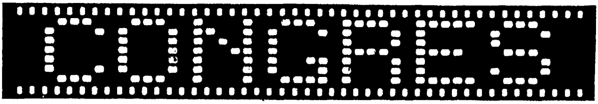
AS THE CAMERA SEES THE SIGN

The "talking sign" as it appears to the camera presents a solid band of illumination, because several words have passed during the exposure of the negative



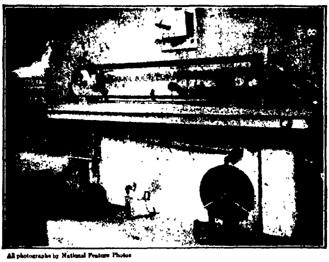
THE PERFORATING APPARATUS

Here the paper tape is passed through a machine where it is punched with various letters as is illustrated below



A SECTION OF THE PERFORATED PAPER TAPE

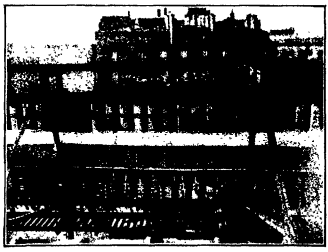
The descriptions of various news events are punched in the tape as they are received from telegraph messages from various parts of the world. The tape is perforated at the edges in a manner similar to motion-picture film so that it can be fed smoothly



All photographs by National Feature Photos

WHERE THE CONTACTS ARE MADE

At this point the paper tape passes between spring brushes and a metallic surface. Contact is made when the holes pass between



THE ENORMOUS BANK OF LAMPS

The electric light bulbs in the housings shown are controlled through wires by the interrupting action of the perforated paper tape

World Events From Flashing Sign

IN many of the larger cities throughout this country, the inhabitants are familiar with the advertising signs that transmit their messages to the public by means of illuminated letters which seem to pass slowly from one end of the sign to the other, being followed by others, which are so spaced that words and phrases are spelled out. There are now two newspapers in France that use a similar but improved sign for transmitting to the public the latest bulletins from the world. The mechanism that is used in these signs is illustrated above. A special machine is used to perforate a paper tape. The operator of this machine receives his information from cables and telegraph lines and at once translates it to the tape. This tape then is run through a circuit breaker, opening and closing contacts which correspond in spacing to the shapes of the letters. In this way banks of lamps are illuminated, and as the tape passes along, the effect as seen on the sign is that the lamps forming the letters move.

"How Do They Know?"

When Astronomers Talk of Galaxies of Stars 60,000,000,000,000,000,000 or More Miles Distant, How Have They Arrived at Such Stupendous Figures?

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory, Princeton University
Research Associate of the Mt. Wilson Observatory of the Carnegie Institution of Washington

AS the nights lengthen and the winter constellations advance into view, the greatest of the nebulae—that of Andromeda—comes into sight. Almost every star gazer knows how to find it—follow the line of stars which runs eastward and northward from the great square of Pegasus, turn off to the northward at the first large star in the line, pass two fainter stars and the hazy, oval mass of light is easily visible to the unaided eye, and conspicuous in a field glass.

We all know, too, how photographs show that the visible portion of the nebula is but the central and brighter region of a vast spiral mass of faint light whose extreme diameter is almost three degrees or six times the apparent size of the moon. The story has been told, too, in these columns how the outer parts of the nebula have been resolved, on Hubble's photographs, into countless thousands of tiny stars, and how, by the discovery of variable stars among them it has become possible to find the distance and size of the whole stupendous system.

HUBBLE'S latest data makes the distance 870,000 light-years, and the extreme diameter 45,000 light-years. Until within comparatively few years ago it was supposed that the whole universe of stars was not nearly as big as this.

Now the Andromeda nebula is by no means a unique object except in its apparent size and brightness. There are hundreds and probably many thousands of spiral nebulae in the sky, similar in general appearance but fainter and smaller. Do they look so because they are really smaller and less luminous, or only because they are farther away? This is not an easy question to answer in the present state of our knowledge; but Hubble has given good reasons for believing that the second of the two explanations is in the main the true one.

To begin with, there are six other nebulae whose distances can be directly measured or estimated by the same methods. Two of these are the great Megallanic Clouds of the southern hemisphere which, if more remote, would appear as nebulae of regular form. Their distances according to Shapley are 112,000 and 104,000 light-years. Among the spiral nebulae Messier 33, which comes next to that in Andromeda in size and brightness, has been resolved and is full of variable stars. Hubble finds its distance to be very nearly the same as that of the Andromeda nebula. Another spiral, Messier 101, shows fainter variables, and Hubble's estimate of its distance is 1,500,000 light-years. [A light-year is, roughly, six trillion miles.—EDITOR.]

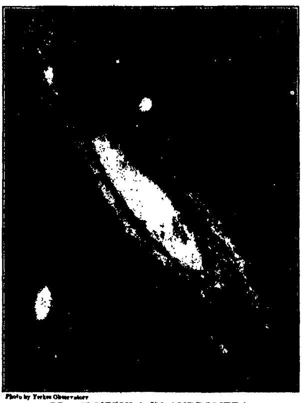


Photo by Yerkes Observatory

GREAT NEBULA IN ANDROMEDA

Only the central part shows to the naked eye. The small nebula directly above the center, in the photograph, is a companion to it

There is another nebula, oval, bright and relatively small, and known as Messier 32, which is close to the great Andromeda nebula in the sky and shows the same radial velocity of 300 kilometers a second. Like its greater neighbor and unlike almost all extra-galactic nebulae it is approaching us. This makes it decidedly probable that the two nebulae are really neighbors and that the distance of the smaller one is in round numbers 900,000 light-years.

Given these distances and knowing the apparent brightness—which has been carefully determined for a large number of nebulae by the Austrian astronomer Holetschek—the real brightness can be calculated. The resulting absolute magnitudes range from minus 17.1 for the Andromeda nebula to minus 13.3 for its companion. That is, the actual light emission for the first is 580,000,000 times the sun's light, and from the second 18,000,000. These values are entirely consistent with the other evidence which indicates that these nebulae are vast clusters of millions and perhaps hundreds of millions of stars. These two nebulae differ a good deal in brightness—one is about thirty times as bright as the other—but they represent the extreme range so far observed. For the seven nebulae of known distance, the mean absolute magnitude is minus 15.1, corresponding to a light 90,000,000 times the sun's.

SUPPOSE we should say that in round numbers a nebula of the sort is 100,000,000 times as bright as the sun, and use this rough value to work out the distances from the observed brightness. For the Andromeda nebula we would get a little less than half the true distance; for the companion rather more than twice too much. For the other five nebulae we would be nearly right. This may not sound very good, but if we previously knew nothing about these distances, a method which, although it gave only rough values, gave us results which were not more than twice too big or too small, would be exceedingly welcome.

But can we trust this estimate to hold good for the other nebulae whose distances cannot be got at directly? What have we to guide us? To begin

with, there are a good many more nebulae (always of the extra-galactic type) in which individual stars can be photographed—as can be done for six of the seven nebulae of known distance (all but M 32). For these six the real brightness of the brighter constituent stars can be found. The absolute magnitudes range from minus 5.5 to minus 8, that is, from 18,000 to 180,000. The brightest stars in the various nebulae are therefore roughly alike in brightness. Their average absolute magnitude, minus 6.4, corresponds to about 40,000 times the sun's light, and the assumption that this was true in each individual nebula would give us estimated distances were quite as good as the first ones.

NOW Hubble has tested 15 other nebulae in which stars are shown. As might be expected, these nebulae are fainter than the first seven, and so are the stars within them. Estimating their distances on the basis that these stars are 400,000 times as bright as the sun, values are found which range from 2,000,000 to 4,500,000 light-years. Now when with these distances we calculate back to the total brightness of each nebula, we find an average value agreeing very closely with out original estimate of 100,000,000 times the sun's light, and fully confirming it.

This is important; for we know no reason why an isolated star cloud should be large or small, bright or faint (although some day we may be wiser). But we are in possession of a sound physical theory of the brightness of the stars, and there is good reason to suppose that what holds true of them, on the average in one star cloud, will also hold approximately true in any other. However, the argument based on the brightness of individual stars deserves to be taken very seriously, and the conclusion that on the average the great extra-galactic nebulae are a hundred million times as bright as the sun is much strengthened by it.

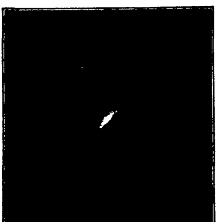


Photo by Mt. Wilson Observatory

A SPIRAL—SIDEWISE VIEW

One more bit of evidence, applicable to a still greater number of nebulae, comes from Hubble's work. The apparent diameters of the nebulae are closely related to their apparent brightness. Taking, for example, those which appear as hazy, circular objects with outspread arms, he finds that if they could all be moved to such distances that they appeared equally bright they would all look about equally big. For those which are oval in form the same thing is true: but, for the same brightness they would appear bigger than the round nebulae.

The spirals, if brought again to such distances as to appear as bright as the rest, would be of still larger diameter. But all the nebulae of each class—round, oval, closely wound spiral or open spiral—would be much alike in apparent size.

Photo by Mt. Wilson Observatory

ANOTHER GREAT SPIRAL

This is M33 in the constellation Triangulum. Note its "pin-wheel" appearance

This is obviously what would happen if the nebulae of a given form were really not only of about the same brightness but also of the same actual size. But by itself it does not prove that the inference is true; for it may be that the fainter nebulae are also smaller—provided that in some way the unknown laws which govern their constitution make their diameters proportional to the square root of the amounts of light which they give out into space.

In view, however, of the direct evidence that twenty or so of the most prominent nebulae are fairly similar in their real brightness, it is reasonable to suppose that the same rule holds for the rest. From this, Hubble figures that a round nebula of the extra-galactic type is about 1000 light-years in diameter (since the light of such a body fades off very gradually at the edge, no exact value can be given). A roughly oval nebula without spiral arms may have a long diameter of as much as 3500 light-years, its shorter diameter being again about 1000. The most widely expanded spirals are, on the average, about 10,000 light-years across and, like the others, 1000 light-years thick at the center where, as is clearly shown in the example reproduced in the illustration at the bottom of this page, they bulge out the most.

Photo by Mt. Wilson Observatory

SPIRAL NEBULA M101

To photograph this distant galaxy required seven hours with a 60-inch mirror

Individual objects like the Andromeda nebula are doubtless considerably larger, and others may be correspondingly smaller. But it appears very probable on the existing evidence that the figures given above for the size and brightness of these nebulae are good enough averages to give us a reliable idea of the distances at which the fainter and more remote of the nebulae lie.

THE faintest nebulae which can be seen with small telescopes are of about the 12th magnitude. If they, like the others, are a hundred million times as bright as the sun, their distances must be of the order of ten million light-years.

With the 100-inch telescope and long exposures under good conditions, it should be possible to distinguish the image of a nebula as faint as the 18th magnitude, from that of a star, and thus to reach objects at the distance of 140 million light-years. Nebulae twice as far away might be photographed, but could not be distinguished from faint stars unless and until a larger telescope than we now possess is provided.

It is therefore not only possible but probable that our great telescopes enable us to observe celestial bodies so remote that the light by which we study them has been upon its way since remote geologic times when the whole face of the earth was different, and reptiles such as the great dinosaurs, not man, were the dominant inhabitants of our planet.

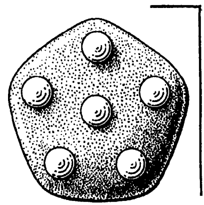
Evolution of the Human Eye

Will Man Eventually Lose One Eye? A Cyclopean Race is Predicted by One Scientist

By W. E. BAILEY

VAST ages ago, probably in some wind-swept, wave-tossed sea, a tiny bit of protoplasm or living cell appeared for the first time on this planet. That is the belief of science. Why this microscopic Adam should thus put in an appearance, and by what process, are mysteries today, although men of science are determined that the riddle must be solved. But they do know, and can assert it with the assurance that all who have eyes will agree, that at some time the process had to start.

No one has ever seen that protoplasmic Adam, but there are many who have seen a tiny animal which must be very much like him—our much-discussed little friend, the ameba. The study of this speck of life has resulted in information which throws light on the riddle of our own existence. Not the least interesting thing about the ameba is the fact that although it has no eyes, it is all eyes, being light-sensitive throughout its whole body. Here, then, we must be quite close to

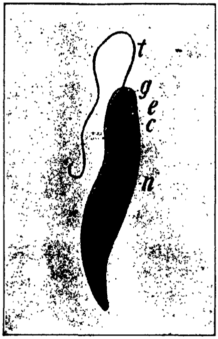


UNDER GREATER MAGNIFICATION

FIGURE 2: *The eye of Figure 1 is seen to consist of six smaller, so-called "lenses"*

the beginning of that most priceless of possessions, sight.

The ameba, being without a mate, adopted an extremely simple and ingenious method of supplying its need for a help-meet: it divided itself in the middle. Billions of times all over the world every day it is still propagating itself in this manner. And not only does it keep its sight, but it passes it on each time it produces this duplicate of itself. It has the property, too, of growing an arm or a leg at will, and, more amazing still, if it wishes, it can lop them off merely by absorbing them into its body again. The ameba has never seen any of its brothers. It is in the predicament of a blind person who can barely tell pitch blackness from bright sunlight.



THE SIMPLEST EYE

FIGURE 1: *Euglena and its eye, under low magnification. The spot e is the eye*

A little farther down—or up, if you prefer—in the scale of life, one might expect to find other simple forms of eyes. Since the amebas kept their eyesight all down through geologic times it is obvious that they used it; and because nature's method has long since been shown to be one of trial and error, and the ultimate a survival of the fittest, students of this fascinating subject concluded that something must have happened when the ameba discovered it could not utilize its light-sensitive body to see food.

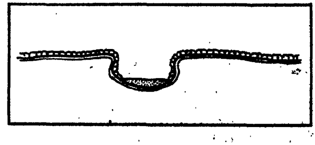
One of these delvers into the secrets which are bound up into that marvellous mechanism we call an "eye," Dr. Thomas Hall Shastid, ophthalmologist of St. Luke's Hospital at Duluth, Minnesota, believes he has found the animal which possesses the first specialized eye. This animal, the *Euglena viridis*, a closely related member of the same group of animals, the protozoa, is on the border line between the microscopic and the macroscopic—the invisible and the visible—worlds, and its eye, Figure 1, is a tiny rose-colored spot(*e*) just below its mouth (*g*).

Although the *Euglena* has never seen a sunset, its eye is decidedly useful. To it the *Euglena* owes its hold on life. Dr. Shastid constructed a box containing three compartments, one brightly lighted, one dimly, and one in darkness. Pouring ooze and water over the floor of all three, he turned *Euglena* loose into the dark compartment. In a short time it was found in the dimly-lighted cell. If placed in the brightly-lighted division it likewise was shortly to be found in the dimly-lighted cell; but if placed in the subdued light it stayed there. Its eyes have the ability to determine what conditions are best, and, obeying them, it is safer than we are when trusting to our eyes as we cross a busy street.

BUT while *Euglena viridis* has what seems to be an extremely simple eye, under high-power magnification, Figure 2, one can see what appear to be six lenses. Science does not agree on the function of these structures; in fact no adequate theory to explain observed data has hitherto been worked out, and this has for many persons been a stumbling block in the acceptance of the evolutionary theory in general. Dr. Shastid is of the opinion that the so-called lenses of the *Euglena* are not true lenses at all, but are the ancestors of the rods and cones of the human retina. At all events, the eye of *Euglena*—the word, from the Greek, means "good pupil"—is not by any means a pupil, because a pupil is not a thing but a hole in a thing, and *Euglena's* eye is a substance, a bit of

CROSS SECTION OF PIT EYE

FIGURE 3: *The light-sensitive pigment is placed for protection at bottom of a pit. This pit forms the beginning of the ball of the subsequent evolution of higher types of eyes*



pigment. It is, in fact, the ancestor of the pigment epithelium layer of our retinas and, in addition, of the pigment in our skins.

This does not imply, of course, that man is the descendent of any of the living protozoans, any more than he could be the descendent of any of the living apes. It is, however, believed that man and possibly all the existing forms of life descended from animals which were not very different from certain protozoans that are living today much as they must have lived a thousand million years ago. In other words, this hypothesis implies that not every individual of every form of life has been subject to conditions that caused it to evolve. This explains the existence in our times of animals that have come down from ancient geological times relatively unaffected by evolution.

The eye of the *Euglena* being constantly subject to injuries, nature seemed to say: "I can surely beat that." So, in slightly higher animals, she made a depression and set the eye down in it, Figure 3. This structure may be seen today in some of the worms, such as the *Capitellidae.* It appears to exist solely for the protection of the eye pigment, and Dr. Shastid's painstaking researches have convinced him that it is plainly the forerunner or ancestor of the globe of the human eye.

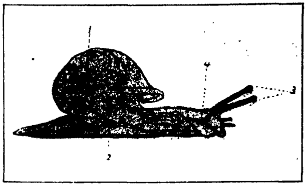
BUT in setting the light-sensitive pigment in a depression, nature had overlooked the possibility that sand and foreign particles could still enter the eye. So, discovering her mistake, nature filled the pit with a viscous, transparent substance which could not flow out of the pit, this material being the ancestor of man's aqueous and vitreous humors. No image of an object could be formed through such an eye, but it was probably because this method did not furnish full protection to the eye that nature grew a shoot of integument across the pit, forming the first cornea. These corneas were probably opaque at first, as in some types of snails today. In some species of snails the closing membrane has not yet quite crossed over.

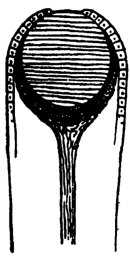
And, because some of these corneas were more efficient than others, due to being thicker in the middle than at the edges, the animals so favored multiplied faster because of a decided advantage over the others in the struggle for existence. Thus came about the development of lenses in the eye.

What other connections there are between the eyes of the invertebrates and the eyes of humans it is difficult to say, for, as Dr. Shastid carefully points out, as one passes over to the vertebrates, and specifically to the fishes, the subject of eye development becomes one of great obscurity; but it is no greater than that which surrounds the pedigree of man in general. As one scientist put it, "We do not know, after more than a century of morphologic study, even whether man and the other vertebrates have descended from a segmented, or an unsegmented, ancestor." That is to say, in a manner of speaking, we do not know whether man came up the trunk of the tree or through the branches!

ORDINARY SNAIL

The eyes are placed at the end of the retractile eye-stalks or ommatophores. The tip of one of these eye stalks is shown in the sketch below, where the shoot of the opaque integument (primitive cornea) can be seen partly covering the front of the eye





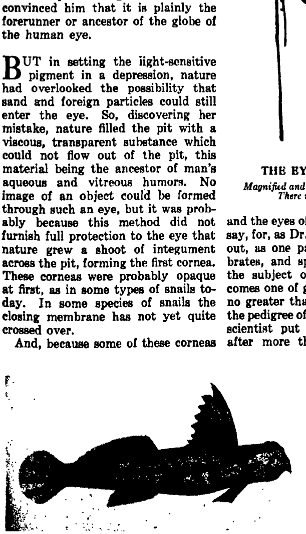
THE EYE OF THE SNAIL

Magnified and in longitudinal cross-section. There is no lens in this eye

Besides having given us backbones, the fish first introduced a true crystalline lens. Fishes also introduced true focusing arrangements, the iris and the pupil, and they almost succeeded in introducing eyelids. Flies, by way of contrast, with their simple and compound eyes, have no need for a focusing apparatus, because their three simple eyes for near objects, and their compound eyes for distances of three or four yards, supply the lack of it. And the wide field of view of the compound eyes obviates the necessity of other than a motionless, jewel-like setting in the head.

BECAUSE no organ can function efficiently without periods of rest, e devised sleep. In the case of vertebrate eyes, because of their delicate organization, other means were necessary in addition, one of these being "motion-blindness" or the inability of the eye to perceive objects while the eye is in motion. The other expedient of major importance is retinal rest, due to eyelids. In a few species of fish are found fixed dermal folds both above and below the eye; in some sharks there is an eyelid in the inner corner of the eye, and a similar lid is found in snakes and birds. There is still a vestige of this fold in the human eye, but the functioning eyelids of man came from the upper and lower eyelids which were started by his distant ancestor, the fish.

Some of the fishes developed lungs, and, finding that they could breathe in the air too, they flopped out on the land. Thus originated the amphibians, animals able to live both in water and on land. Their pectoral fins became shoulders and arms, their ventral fins were slowly changed into hips and legs. The radical changes brought about in their living conditions required a readjustment; but that the transition is not yet complete is evidenced by the fact that every embryo child has gills at a certain



WALKING FISH

Periophthalmus, a sea fish that goes ashore and walks around on its pectoral fins. From a geologically ancient type of fish which gradually acquired this habit all the existing land animals, including man, are believed to have descended, as is explained in any textbook or general treatise on evolution

stage of its early foetal development.

In the depths of the sea fish found that their sight apparatus was quite sufficient. But, exposed to bright lights and to the struggle for self-preservation, new devices were necessary to render the eyes capable of adequate service. Nature therefore contrived to protect the eyes of fishes against the terrific strain now put upon them; and the result was eyelids. The amphibians developed eyelids from the meager beginning made by the fishes, and particularly the lower eyelid. In fact, the frog developed his to the extent that he winks his lower lid upward, whereas the human winks his upper lid downward.

NO fish ever shed any tears because of the sympathy freely poured upon him. It was the amphibians who presented the world with weeping facilities: lachrymal secretion and drainage. The snakes, belonging to the family of reptiles, made little contribution to eyes, although they have both an upper and a lower eyelid. Their eyelids are chiefly to protect their eyes against scratches as they glide past sharp sand, briars and thorns. These eyelids, however, are fused together, and transparent, except at shedding time when they become opaque. This provides an explanation for the periodic blindness to which snakes, as every farmer knows, are subject.

From the hideous reptiles branched off both the mammals (animals which

THIRD EYE OF LIZARD

suckle their young) and the birds. But which of these two came first is not known. At all events the primates (the highest division of the mammals) possess pupils which are round. The primates developed stereoscopic vision, which is vision of the same object through both eyes at the same time. In monkeys, stereoscopic vision can be obtained but not long held; in the apes this type of vision comes much more easily; but only in man is there continuous, readily maintained stereoscopic vision—although in children the eyes do not as a rule move in perfect unison until about three months after birth.

Because of the development of a speech center in man, there has come about what is called dominancy and

LIGHT-SENSITIVE SKIN

To escape from the Periophthalmus, the Onchidium has developed eyes on its back

serviency in human eyes, a phenomenon not found in the other mammals. This means that, in the human, the brain does most of the seeing through one eye, even when both eyes are open. Dr. Shastid has found that from 95 to 100 percent of the detail of any object comes through the right eye if the person be right-handed; while if the person be left-handed the left eye as a rule, but not always, takes up the major part of the detail. This condition, which he has been unable to observe in any other animal, may eventually result in consequences of vast importance to humanity. But let Dr. Shastid tell it:

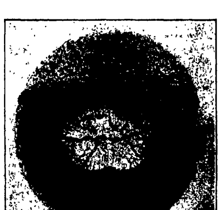
"IN the course of generations, man's 'field' of view will become smaller and smaller. This, because his need of a wide field is growing less and less. This I say with full realization that we live in an age of automobiles, and that these vehicles render desirable a wide field of view. The automobile is probably a very transitory phenomenon. I even believe that, in the course of countless ages, the two human eyes will come closer and closer together, the bridge of the nose will further diminish and sink (just as the animal snout, in man's line of descent, has been doing for vast aeons of time) and, finally, man's two eyes will again become one—just one large, central, cyclopean eye.

"It is likely that the merely servient (left) eye will shrink away (as the pineal eye has already done) so that the right eye will become the cyclopean. Certain it is that the left eye, even today, is being used less and less continually. Man's binocular and stereoscopic visions are being destroyed. That is the price he pays for his speech center.

"The great cyclopean eye, however, will regain stereoscopic vision by developing two maculae in the one eye, just in the fashion in which many birds have stereoscopic vision in each eye now. Although the field of view will then be narrower than now, the eye will probably be microscopic and telescopic; it will be exceedingly acute for colors, for motion, and for form; and, finally, most important of all, it will probably be able to perceive as light many forms of energy which now produce in human eyes no sort or kind of perception.

"EVOLUTION of the fleshly eye has been, for man, in the more recent stages of his progress, much too slow. So man invented the microscope, the telescope, the spectroscope, and even the X-ray apparatus which permits him to see through opaque objects. Nature, seeking valiantly to help man's eyes adjust themselves to the new set of conditions wherein man reads, writes, repairs watches, cuts gems, examines pictures and so on, has done so in two different ways—one bad, one good. The bad way has been by making him near-sighted. The near-sighted eye, at rest when looking at near objects, is always a diseased eye. But the normal-sighted eye, supplied with a very strongly developed focusing apparatus for near objects, will, I am firmly convinced, survive the competition.

"At all events, the law of evolution is as interminable as the law of gravitation. I may be mistaken in my prophecy of the exact changes which are yet to occur in the human eye, but on one point, surely, it is impossible to be mistaken. That point is that there will be change. The entire spiritual, intellectual and physical universes in which man lives will change. And man himself, his eyes included, will inevitably change with them."

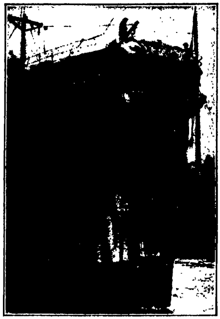


INSIDE OF HORSE'S EYE

Back of inside of horse's eye. It is the upper part which sees the road at night

Safety at Sea

American Ship "Malolo" Survives Terrific Collision



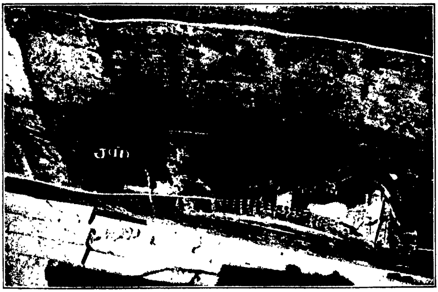
CRUMPLED BOW OF "CHRISTENSEN"

Remarkable toughness of folded-up ship plating is shown by this photograph

AFTER the tragic loss of the *Titanic* in 1912, due to collision with an iceberg, the leading naval architects of the world met in London, and the International Conference, as thus assembled, laid down certain rules for ship construction, designed to safeguard life at sea.

The recently completed passenger ship *Malolo*, 582 feet long, 83 feet beam, 22,000 tons displacement on a full load draft of 28½ feet, and 22 knots speed, was designed by Wm. F. Gibbs of New York in full compliance with the International Conference requirements. Furthermore, he exceeded the Conference stipulations by installing a central control system for the simultaneous closing of all scupper valves, thus preventing flooding through these valves—a frequent contributory cause of foundering. Mr. Gibbs also gave special attention to stability as a safeguard against capsizing.

At the very outset of her career, on her trial trip in fact, the *Malolo* was rammed squarely amidships by a heavily loaded Norwegian ship, the *Jacob Christensen*, which struck her squarely on the bulkhead between two boiler rooms, both of which were opened to the sea and flooded. The stem of the *Christensen* protruded below water and ripped open the plating, from just above the boiler floor to a height of 15 feet. It was a terrific blow; but the instant closing of the watertight bulkhead doors and the scupper valves, coupled with the heavily stiffened bulkheads, saved the ship. With some 5000 tons of water in her two boiler rooms, she settled to 36 feet draft forward and 26 feet aft, but showed only a slight list to port.



...graphs by P. and A.

WHERE "MALOLO'S" PLATING WAS CRUSHED IN

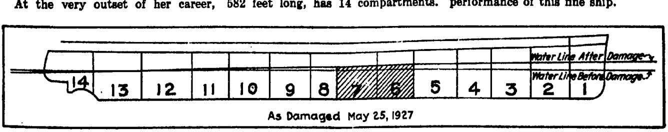
Bow of Christensen *struck* Malolo *squarely amidships and ground along her port side for a distance of 25 feet, bursting in her plating and admitting some 5000 tons of water*

The International Conference called for closer spacing of bulkheads, resulting in smaller compartments. Note the improvement of the *Malolo* over the *Titanic*. The latter, 886 feet long, had only 15 compartments; the *Malolo*, 582 feet long, has 14 compartments. The *Titanic*, if her engine-room compartment had been pierced, would have taken in 5000 to 6000 tons of water. The *Malolo*, with her two midships compartments flooded, took in only 5000 tons.

Mr. Gibbs, writing in *Marine Engineering*, says "While the provisions of the International Conference for Safety of Life at Sea, held in London in 1914, have not yet been adopted by this country, the *Malolo* complies strictly with these rules." Why this astonishing neglect? Are we altogether indifferent to the safety of American voyagers?

ANOTHER most important safety provision, which the writer strongly urged at the time of the *Titanic* disaster, was the raising of the bulkhead deck, and hence the bulkheads, to a higher level. In the *Titanic* the bulkheads extended only 10 feet above the load line; but in the *Malolo* they rise 16½ feet above water amidships, and at the bow 21½ feet. Moreover, by reference to the accompanying diagram, it will be seen that the collision bulkhead extends one deck above the bulkhead deck.

The owners, the Matson Navigation Company, and Mr. Gibbs, the designer, are to be congratulated on the performance of this fine ship.



SKETCH SHOWING EXCELLENT BULKHEAD SUBDIVISION

...r to loss of Titanic, *bulkheads were spaced too widely; they did not ...nd sufficiently high above the water; and compartments were too large. The* Titanic's *bulkhead deck was only 10 feet above water a... ships; but the bulkhead deck of* Malolo *is a full 16½ feet above ...*

All photographs courtesy of the General Electric Company

ONE OF THE HUGE AIR-COMPRESSING MACHINES

In order that argon gas may be extracted from the atmosphere, the air must first be compressed to a pressure of 4000 pounds per square inch. Above is shown one of the machines that accomplishes this stupendous work

Nobility at Work

How Some of the "Noble" Gases Are Finding Valuable Applications in Industry

THE air is composed of about four-fifths nitrogen, one-fifth oxygen, a small amount of carbon dioxide and traces of other gases, such as helium, argon, neon, krypton and xenon. It is less than 35 years ago that any one of these latter was obtained for the first time. They are not elements which can be mixed with other elements or compounds in test tubes or retorts to produce new compounds, for these gases are "noble" ones, and in more ways than one.

Xenon, for example, is present in the air in the proportion of only one in 170,000,000 parts; argon, the most common of the five, forms only about 94/100ths of 1 percent of the air. Such rarity makes these gases noble; not only are they uncommon, but they refuse to join with any other elements, or even with the others in their own exclusive circle, in the formation of chemical compounds. They are even more noble than are the "noble" metals—gold, platinum, iridium, et cetera—which are not tarnished by exposure to the atmosphere but which can be made by the chemist to combine with other elements in the formation of new compounds. The noble gases are sufficient unto themselves; and it is not surprising, therefore, to note that little space is devoted to them in the average textbooks on chemistry.

Of the five rare gases—argon, helium, neon, krypton and xenon—three are now at work. The other two, krypton and xenon, could be made to labor, but they are so rare that to harness them commercially would hardly be feasible. All of them are being given off constantly by the earth in springs, in natural gases, by volcanoes, and even from rock formations.

HELIUM was the first of the five gases to be discovered. It was found by Lockyer in 1868 in India, but, seemingly paradoxical, it was not in India. Its exact location at the time was about 93,000,000 miles away, and the time was that of a solar eclipse. By means of the spectroscope, scientists discovered in the corona of the sun a gas which had not been found on the earth. To the new element was given the name helium, from the Greek word *helios*, or sun.

It was not until 1895 that Ramsay discovered the gas in the earth's atmosphere. During the World War, helium attained prominence because of its value for inflating dirigibles. Being inert, it is non-inflammable and non-explosive, and, being buoyant, it is ideal for use in balloons, except for its cost. Before the war, helium could be distilled from the air at a cost of about 1700 dollars per cubic foot; today the production cost is but a small fraction of that amount. Even so, however, the expense of filling a dirigible with it is more than a quarter of a million dollars.

As for neon, which constitutes one in 55,000 parts of the air, it has been found that a beautiful red glow is produced by passing an electric discharge through a glass tube containing a slight amount of the gas. Hence neon is now commercially at work in a novel type of electric sign in which letters or designs are made from glass tubing. Neon, from the Greek word *neos*, or new, was discovered in 1898 by Ramsay and Travers.

Krypton, from the Greek word *kryptos*, or hidden, and xenon, from the Greek word *xenos*, or strange, were also found in the same year, 1898, by the same two men.

Argon was first obtained by Rayleigh and Ramsay in 1894-1895. The name is derived from the Greek word *argos*, or inactive. It is the commonest of the five noble gases and is by far the most valuable commercially, saving us annually three hundred million dollars in electric light bills.

OF the tungsten-filament lamps, the larger sizes are gas-filled and the smaller ones are vacuum lamps. The 1926 production included 173,000,000 vacuum lamps and 121,000,000 gas-filled ones. The vacuum lamps averaged 33¼ watts each, and the gas-filled ones 96 watts. The amount of light produced by each type was not in proportion, however. The average gas-filled lamp consumed nearly three times as much current but produced 4½ times as much light. Thus the gas-filled lamp of 1926 was about 55 percent more efficient than the average vacuum lamp.

Two gases are used, nitrogen and argon. Nitrogen is inert in that it does not combine readily with other substances, but it can be made to participate in many reactions. Different mixtures of nitrogen and argon are used for different sizes and types of lamps, with practically all argon in the case of the average size lamp, and about half nitrogen in the large, high-voltage lamps.

The point might be raised as to why the gas-filled lamp has not superseded all vacuum lamps since it is so much more efficient. The answer is that special operating conditions exist with gas-filled lamps, in that a special design of filament is needed, et cetera, so that gas-filled lamps consuming less than about 0.4 ampere are as yet less efficient than vacuum lamps.

Although as stated, Ramsay discovered argon in 1894, for 20 years no practical application was made of it. In 1913, however, Dr. Irving Langmuir, in the Research Laboratory of the General Electric Company, put a little argon in a lamp bulb containing a specially designed tungsten filament.

ARGON-FILLED LAMPS

The machine illustrated removes the air from glass lamp bulbs, puts argon gas in the evacuated space and seals the bulbs

The presence of the gas made it possible to increase greatly the amount of current passed through the filament and to increase its temperature. The higher the temperature, the whiter and brighter the light produced, and the greater the efficiency.

Early experimenters had tried gas-filled lamps, but the vacuum carbon lamp was found to be better. Dr. Langmuir's experiments showed, however, that a tungsten filament heated in a gas-filled bulb entirely freed from water vapor lasts longer than when heated in a vacuum; and that the heavier the gas, the slower the evaporation of the tungsten. For example, it was found that argon reduced the filament evaporation to 1 percent of that which occurred in a vacuum at the same temperature.

THE addition of the gas to increase the life of the filament means an additional heat loss, but, by using either a large filament or a coil of small filament, the heat loss has been overcome by the higher temperature and the improved quantity and quality of the light.

The argon used by Dr. Langmuir in his experiments back in 1913 was imported from Europe and cost 10 dollars per cubic foot. Many thousands of cubic feet of the gas are now used every week in lamp manufacture, and, needless to say, the cost of argon today is far below the figure for 1913.

Just at the time the World War was beginning, an American, J. G. Wild, succeeded in escaping from Europe with a sufficient quantity of the then hard to obtain argon gas with which to conduct exhaustive experiments in producing and purifying the gas. By the fall of 1914 the characteristics of the gas had been learned to such an extent that it was possible to supply the lamp development laboratory of the National Lamp Works at Nela Park, Cleveland, with some argon for use in lamps. In February of the following year regular shipments of the gas were started to different lamp factories. Crude argon—with varying amounts of other gases as impurities—was purchased from an air-products company in this country and purified in the laboratory before shipment to the lamp factories.

Each year found the consumption of argon much larger than that of the preceding year, and in 1919 a complete argon production and purification plant was built at Cleveland. Here clean air is sent through a pipe to a compressing machine where a pressure of 4000 pounds per square inch is applied.

More than simply pressure is required, however, if the air is to be reduced to a liquid; its temperature must be reduced to 220 degrees below zero, Fahrenheit. The compressed air is therefore directed into interchangers, tanks in which the temperature is decreased almost to the point where the air becomes liquefied.

From the interchanger, the highly-compressed and low-temperature gas passes through an expansion valve into the fractionating column or still.

PURIFYING ARGON

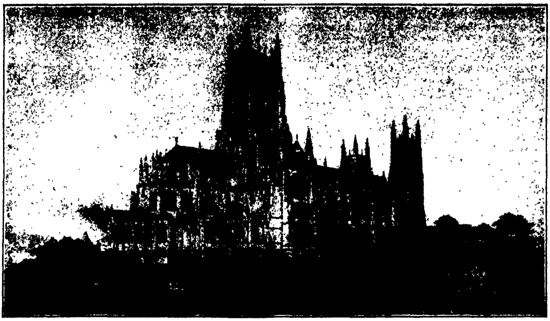
This is the equipment used for purifying the crude argon delivered from the compressor

This still is heavily insulated to keep out heat, for the temperature within the still must be 300 degrees below zero. When the air goes through the expansion valve the pressure suddenly drops from 4000 to six pounds per square inch. So suddenly is the pressure lessened that the temperature decrease is sufficient to cause the air to become a liquid.

THE air in the still has been liquefied by compression, chilling and expansion, but it immediately starts to turn back into gases. The nitrogen is the lightest or most volatile of the mixed gases, so it is the first to return to the gaseous state. The oxygen, which is heavier, trickles down the sides of the still as a liquid. The argon starts to go with the oxygen.

Part way down the sides of the still, however, the argon begins to become a gas, following the example of the nitrogen. But the apparatus is so constructed that the argon, becoming a gas, is unable to join the gaseous nitrogen with which it parted company at the top of the still. Instead, it is trapped and led to tanks labelled "Crude Argon."

The impure, or crude, argon piped from the still is subjected to a heat treatment which removes the impurities. Then it is compressed again and loaded into cylinders, ready to be shipped to lamp factories in all parts of the world. Each cylinder holds 300 cubic feet of the noble gas, which weighs slightly less than 30 pounds. Open the valve of one of the cylinders and a hissing sound can be heard as the argon escapes; but as for seeing, tasting or smelling the gas, it can't be done.



CATHEDRAL OF ST. JOHN THE DIVINE

Final design of the world's third largest cathedral, showing the square tower which has been substituted for the original spire. Length of church 601 feet, interior height of nave, floor to vault, is 125 feet, height of central tower 400 feet

Building for the Ages

Built of Large-Size Stone, Bedded in Cement Mortar, St. John's Cathedral Should Be As Lasting As the Pyramids

By J. BERNARD WALKER

UPON its completion, St. John's Cathedral will take rank as the third largest place of worship in the world. The basis of this comparison is the total ground surface covered by the building. St. Peter's, Rome, stands first with an area of 227,069 square feet; Seville Cathedral, Spain, second with 128,570 square feet. These are followed by St. John's, New York, which will cover 109,082 square feet. In exterior length, it will stand second, measuring 601 feet as compared with St. Peter's, which measures 710 feet.

Architecturally considered, the crowning glory of St. John's will be found in its truly noble nave, in which, by the insertion of two lines of majestic piers 85 and 98 feet in height to assist in carrying the vault, the architect has been able to secure a clear nave width of 96 feet between the clerestory walls. This is several feet wider than the nave of St. Peter's, which is given as 85 feet by Fletcher in his recent notable work, "A History of Architecture."

When Mr. Ralph Adams Cram was confronted with the task of remodeling the Romanesque design of the first architects, Messrs. Heins and La Farge, he decided to adopt the style known as Thirteenth Century French, as developed by the medieval cathedral builders in those superb examples, Notre Dame and Chartres, Amiens and Rheims. The style is marked by great simplicity and dignity and a sparing use of the elaborate sculptural and other decorative effects which were to characterize the later decorated, flamboyant and perpendicular cathedrals of France and England.

So felicitously has Mr. Cram adapted the Thirteenth Century style to the ritual and congregational requirements of a Protestant Cathedral of the first rank, that the writer, at least, does not hesitate to say that St. John's, both within and without, will surpass its great prototypes in that particular quality of combined simplicity and dignity to which we have referred. When the student who has familiarized himself with medieval cathedrals, first enters the nave of St. John's, looks through the two lines of soaring columns that sweep, unbroken, from floor to roof, and appreciates the vast stretch of 96 feet from clerestory window to clerestory window, he will realize that here is something which, for sheer majesty of effect, is unmatched among all the cathedrals of the world.

WEST END OF NAVE

View shows piers completed and main arch weighing 250 tons under construction

But the purpose of the present article is to deal with the permanence, the enduring quality of the construction of America's greatest Cathedral. How long will it endure? For how many generations, throughout how many centuries, will it stand the buffeting of wind and weather, the alternating attack of torrid heat, driving rain, and disintegrating frost? The writer was asked that question by a visitor from the west, who had traveled far to look upon the structure, of whose vast proportions he had heard so much. We answered, "If you could

return to earth five thousand years from now, you would find St. John's standing, to all outward appearances, as you see it today." In explanation of our confidence, we quoted a well-known sculptor, who was then engaged in carving a monumental work upon the vertical face of a mountain of solid granite. Wishing to know the probable rate of disintegration of the granite, he consulted the state geologist, who, after a careful study of the problem, which included laboratory tests, set down the rate of wear of the surface at one inch in several thousand years.

INTERSECTION OF THREE GROINS

View from platform above nave vault showing the three massive intersecting groins, or arches, seen in the lower left-hand view of the nave. The keystone weighs five tons

Now, the exterior of St. John's is clothed with selected granite of a quality equal to that above referred to. If the action of the weather removed one inch in five thousand years from the granite face, the loss would not be visible to the eye, even on the bold and massive carvings and mouldings that adorn the structure.

Similarly, the interior surface of the cathedral, which is of selected Indiana limestone, a material which hardens under atmospheric effects, will suffer no disintegrating effects that will be noticeable as the centuries pass by.

There remains as a cause of failure the question of faulty design, poor materials, and careless workmanship; and it is here that St. John's greatly surpasses in its structural strength and workmanship the cathedrals of the Middle Ages.

In those early days, money was scarce and the world had lost many of the secrets of construction, notably that of the making of the cement, which had rendered so lasting the work of those master builders, the Romans. It was an age of small-stone-and-mortar construction. Lack of suitable tools and appliances at the quarries, poor roads and inadequate means of transportation, and the lack of capital, drove the early builders to the use of building stone of small size; and in binding together this material in their piers and walls, they were restricted to the use of lime mortar--some of it good, but much of it, as many a catastrophe proved, of wretched quality.

THE MAJESTIC NAVE

Note the noble line of piers, 86 and 98 feet high, which assist in carrying the vault The nave is 98 feet in width

It was no uncommon occurrence for the tower over the central crossing to come crashing down, not many years after the completion of the church. Sometimes the disintegration of the masonry would be gradual, as in the case of the tower and spire of ancient Chichester Cathedral, which fell as late as the middle of the Nineteenth Century. It is to the early fall of the tower of Ely Cathedral that we owe the beautiful octagon built in its place to cover the crossing. The curious double arches at Wells were hastily thrown up to buttress the four piers that were yielding under the weight of the tower. The lovely tower and spire at Salisbury, the top of which leans some two feet out of the perpendicular, owe their present security to emergency measures in the shape of 112 flying buttresses and inclined stone struts, without and within the walls of the cathedral, to say nothing of a score of iron bands inserted to hold the sliding masses of masonry together.

Nor were the great French cathedrals exempt from trouble. The 500-foot spire of Beauvais Cathedral crashed down upon the crossing; and, twice, the vault, 157½ feet in interior height, thrust out the walls of the choir and fell upon the choir stalls and altars below. In rebuilding Beauvais, the number of piers in the main arcades was doubled, and additional buttresses were run up between the walls and the original buttresses.

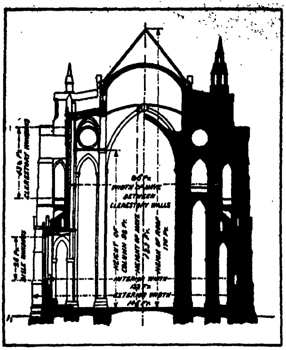
Professor Goodyear believed that the outward inclination of the clerestory walls of the great French cathedrals was intentional, and was done to counteract the foreshortening effect, as the eye of the spectator ranged upward. The writer believes that this effect was due entirely to the settlement, or closing up, of the masonry under the thrust and counterthrust of vault and flying buttress. A similar displacement, in the opposite direction, occurred when the unbalanced thrust of the aisle arches pushed the lower half of the piers inwardly towards the nave, thus accentuating the outward inclination of the clerestory walls.

Now, all of these effects may be traced either to faulty design, due in some cases to a lack of technical knowledge of the amount of thrusts and loads that would be developed, or to what looks suspiciously like a happy-go-lucky, cut-and-try method of building. Not to all of the cathedral structures do these remarks apply. There are some, like Salisbury (if we except the tower and spire, which were never contemplated by the original architect) which stand today as secure and perfect as when they were consecrated five to seven centuries ago.

St. John's has been designed and is being built with a careful avoidance of the pitfalls which so often brought disaster to the medieval churches. The load upon every pier, the thrust against every buttress, has been calculated with close exactness. The crushing strength and the safe limit of loading of each kind of stone are known, and all the parts are so proportioned that in every element of the vast structure

EXTERIOR VIEW OF NAVE

The massive buttresses are necessary to resist the outward thrust of the stone vault. The exterior is of massive simplicity



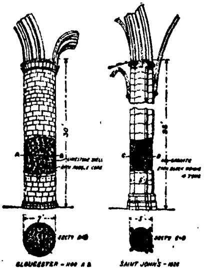
SECTIONS THROUGH THE NAVE

There are no flying buttresses as in medieval cathedrals. The space they would cover is here included in the nave, rendering this the most spacious nave in the world

there will be a wide margin of safety.

It is safe to say that the piers of St. John's will forever remain as plumb as they are today. Turn your attention to the drawing showing a cross-section through one of the vast abutments, and you will feel satisfied that the thrust of the nave vault, great though it will be, will never push these huge masses of granite from their appointed positions.

As regards the materials of construction, St. John's may be called a big-stone job. To make clear what we mean by this, we have made a comparative drawing of a pier of Gloucester Cathedral (1100 A.D.) and one



MEDIEVAL V. MODERN MASONRY

Gloucester pier (1100 A.D.), outer shell of cut stone with core of rubble and lime mortar. St. John's, 4-ton granite drums,

of the intermediate piers of St. John's. The builders of the Twelfth Century, Norman Church, and of all later medieval churches, could not afford to construct their piers of cut stone throughout; so they built an exterior shell of fine squared stone, from six to twelve inches thick, and filled in the center with a core of rough, broken stone, set in lime mortar.

When the load of the upper walls came upon such piers, the rubble core settled more readily than the carefully jointed ashlar casing, and the shell carried the greater part of the load. With the passage of the centuries, the mortar frequently disintegrated, the center rubble core lost its bearing quality, and practically the whole load rested on the thin outer shell, which would bend or bulge, flakes of stone splitting off, and the work threatening an early fall.

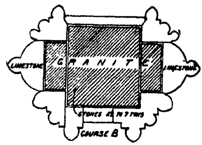
THIS is the trouble with the piers that carry the dome of St. Paul's, which, upon investigation, were found to consist of a thin shell of Purbeck limestone, backed by a mass of badly disintegrated rubble and lime mortar. They are being strengthened by injecting liquid cement under high pressure.

In several instances the threatened collapse of the towers of medieval cathedrals was met by heroic efforts to hold up and repair the heavy masses of crumbling masonry. "Murray's Handbook" records in dramatic description, work of this character. Take the case, for instance, of the enormously heavy tower of St. Alban's, with walls six or seven feet in thickness, which was saved from imminent collapse in 1871.

The tower, thousands of tons in weight, was crushing the massive piers upon which it stood. The mortar used in building the piers had become pulverized. The tower leaned gradually to the northeast pier, which burst open, causing rents from the crown of the northern and eastern arches which extended upwards to the parapet at the top of the tower. "Adjacent arches were hastily bricked up and double shores and trusses were inserted. A cluster of heavy timbers, abutting diagonally against the northeast corner of the tower, bent like bows under the pressure and the northeast tower crumbled until there was a continuous shower of dust and small particles dropping around it. After many days

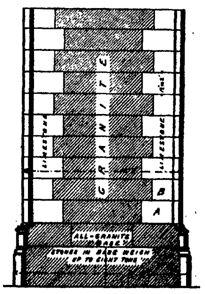
downward progress of the tower was arrested. The great trusses in the northern and eastern arches had caught the shifting mass and were upholding it." The tower was then rendered secure by inserting cement concrete in the foundations and by repairing the tower and piers with brickwork and liquid cement grout.

Not always, however, did these emergency measures save the medieval tower from disaster. Take the case of the charming old cathedral of Chichester dating from the 12th and 13th centuries, the piers of whose central tower, after centuries of service, began to give way.



SECTION THROUGH MAIN PIER

Quoting Murray: "In the northwest tower, fissures were discovered wide enough to admit a man's arm. Iron clamps and traps had been applied from time to time to stay progress of the settlement. New stone work was built up, parts of the piers were recased and bonding stones were inserted—but as this work went on, the amount of bad construction, disintegration and decay in the old masonry, developed itself in a manner exceeding all experience, and presented most serious and unexpected conditions. Old fissures ex-



VERTICAL SECTION

Base is all granite, of stones wei tons. The successive courses of granite and limestone are bound

tended themselves into fresh masonry and new ones made their appearamce. Shoring was resorted to, but the walls began to bulge. Cracks and fissures, some opening and others closing, indicated that fearful movements were taking place throughout the parts of the walls connected with the western piers; and it was determined that the bulging should be checked by applying a jacket of solid timber.

"The work continued, with new fissures appearing and failures increasing, until the following Wednesday, when crushed mortar began to appear from the old fissures. Flakes of facing stone fell and the braces began to bend. Work continued far into the night, but before noon it was seen that the fall of the tower was inevitable. Inhabitants living near the building were warned and not long after noon, the spire inclined slightly to the southwest, then descended perpendicularly into the church, as one telescope tube slides into another . . . the mass of the tower crumbling beneath it.

"THE ruin presented a compact mass of detached materials puddled together in the form of a rounded hill which rose at the summit nearly to the level of the triforium capitals, and sloped gradually downwards into the four arms of the cross."

Consider the piers of St. John's. The main piers, measuring 11 feet by 16 feet, three inches, consist of a heavy outer casing of Indiana limestone, with an inner core of massive, squared granite blocks, each weighing from 5½ to 7 tons. The limestone casing consists of selected stones, most of which are several tons in weight. Not only is the work set in a concrete mortar that hardens to the consistency of the stone itself, but, at each course, it is tied together by galvanized iron clamps, one half inch thick and two inches in width, as shown in one of the accompanying drawings.

Consider also the more slender piers, intermediate with the main piers. These have the amazingly slender proportions of a least diameter of five feet to a length of 98 feet, or about one to 20. To guard against any buckling under the load they carry, it was decided to make each course of a single granite block, of a maximum diameter of seven feet, measured across the mouldings. These blocks weigh up to four tons apiece, and, set as they are with thin cement-mortar joints of great tenacity, they give these tall piers approximately the strength of a single monolithic shaft.

The same combination of durable, selected stone, cement mortar, abundant iron clamping and careful workmanship, prevails throughout the whole fabric of the cathedral—it is built for the ages.

And a word about the workmanship. The contract was awarded to the firm of Jacob and Youngs, Inc., who have thrown themselves with manifest enthusiasm into the prosecution of this great work. By the use of the most up-to-date erecting plant, they have carried up the majestic nave of this cathderal at a rate which has never, we believe, been approached in any previous work of this kind. In great part, this has been due to the unique design of the steel scaffolding, which extends the full length of the nave and which serves to carry the steel centering upon which the great arches of the nave have been built.

MATCHING the zeal of the contractors, is the keen interest which is everywhere manifest among the men. As an engineer, the writer can state that never has he seen a finer job of masonry, or one in which the cutting of the stone and its setting showed greater evidence of exactitude and care. There is a suggestion, indeed, of the loving care with which the medieval builders, as at Chartres, bent to their task. The medieval cathedral was at once the most majestic and most beloved building in the cities which it so grandly dominated. Noble and peasant would labor, sometimes side by side, in its erection.

"The men seem to be deeply interested in this work," I remarked to one of the master workmen. "We are," he said. "At heart I know that I am. This is the third cathedral I have helped to build; and I feel it is an honor to labor upon a great work like this that is being raised to the glory of God."

WITHIN THE GREAT CROSSING

This will afford one of the most impressive views in St. John's. The lower section is 100 feet square. If the tower above had been carried up on this dimension, it would have presented too great a bulk and dwarfed the cathedral, despite its great size, throwing the design out of balance. The problem was solved by building four massive, intersecting arches, 60 feet apart, over the crossing. Upon these will stand a tower 60 feet square. Interior height, floor to vault, 240 feet

Successful Inventors—XI

How a Piece of String, Plus a Paper Bag and an Idea, Equalled a Nation-Wide Business

By MILTON WRIGHT

"THE opportunities for profitable invention today are practically without limits. The American people are always wanting things and they have the money to pay for what they want. What more favorable situation could an inventor ask for?"

So says Walter Henry Deubener, who developed, from a simple little invention, a business which extends from coast to coast. All of Deubener's success is bound up with a paper bag and a piece of string.

INVENTORS NEED INSPIRATION

Mr. Deubener's source of inspiration is pictured with him. "The business wouldn't be what it is without her," he says

Deubener was a grocer. With his wife he ran a cash and carry store on the balcony of a ten-cent store in St. Paul, Minnesota. Being ambitious for bigger and better business, they tried to please their customers in every way possible and to induce them to buy as much as they could. How to get women to pay for and carry away more groceries with them—that was the problem the Deubeners used to lie awake nights trying to solve.

"MANY times a day I would notice that a customer's purchases were limited by her arms rather than by her pocketbook," said Deubener in explaining how he arrived at his invention. "I realized that if I could make packages easy to carry, my customers would buy more and would keep coming back. With this in mind we built a special wrapping counter where several articles were wrapped together in strong paper, tied with heavy string and a wooden handle attached. This helped somewhat, but we found that it cost too much, not only for the supplies but for the clerk's time as well. Then, too, the finished package usually was untidy and too awkward for the customer to handle easily.

"Next we tried selling market baskets. They showed a saving in clerk's time, but there were a lot of objections. They took up too much space in the store and the customers didn't like to carry them, because the baskets scuffed their clothing. For month after month we wrestled with that problem. We couldn't forget it if we tried, for not a day passed without several customers saying, 'Yes, I need this,' or 'I should buy that, but I can't carry any more.'

"I used to lie in bed at nights thinking about it, and one night the solution came to me. Mentally I took a paper bag and punched two holes in each side near the top and two near the bottom. Then I passed a strong double cord through the holes and around under the bottom and extended it upward to form handles at the top.

"As soon as we got to the store the next morning we grabbed up the first empty paper sack we could lay our hands on and passed a looped length of common white wrapping cord around it and through the holes just as I had visioned it the night before while lying in bed. We stuffed it full of canned goods—50 pounds or more—and carried them easily around the place. The paper didn't tear because the weight was supported by the two portions of the string passing under the bottom of the bag. We realized that at last our problem was solved."

"How soon did you place your bag on the market?" we interrupted.

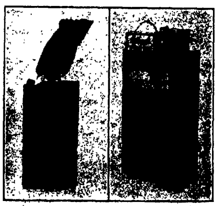
"Only after we had seen a patent attorney," he replied. "We believed we had something in which there were great commercial possibilities and we didn't want anyone else to reap the profits which we thought should be ours. As soon as that first bag was completed we hurried to a patent attorney, explained what we had and asked him to apply for a patent. Only then did we feel safe in taking any steps to commercialize the invention."

"And did you wait until your patent was issued before you placed your bag on the market?"

"No. Why wait? Such paper bags as I had invented were needed right away. Returning from the patent attorney's office, we bought a few ordinary bags and some one-pound balls of string which we cut into nine-foot lengths. (Today we buy our string in carload lots. We punched holes in the bags with an ice pick and ran the string through in the way we had done with the model we had taken to the patent attorney. We made 25 bags in all. Then we cut out colored pictures from the covers of magazines and pasted them on the bags to make them look attractive, for it has always been a theory of ours that an attractive-looking article has many times the selling value of an article of poor appearance.

"WE took the 25 bags to the manager of the 'ten-cent store' where we rented space for our grocery and asked to place them for sale at ten cents each on one of his counters. He consented. Within a half hour they were all gone.

"Feeling now that the value of the invention had been demonstrated we hired two women and set them to work making bags in a small space in a basement. They made 125. These, too, sold as soon as they were placed on sale. Then we went to the head buyer of the 'ten-cent store' chain and he gave us an order for bags to be sold in all of his stores. Next we went to the buyer for the Minneapolis district of the biggest chain



THE SHOPPING BAG DEVELOPS

Deubener's first bag (on the left). Better paper, improved machinery and more attractive decoration enable the latest model to fight dangerous competition successfully

of 'five and ten-cent stores' in the country. He, too, listed them for a trial. They were a success and then they were bought for the 'ten-cent stores' all over the country as well as Canada and Cuba.

"Meanwhile we had moved our workers out of the basement and into a storeroom. We hired a girl and I quit being a grocer and became a factory man. The business was growing fast and I was the busiest man you ever saw. I was sales manager, shipping clerk, machinist, factory superintendent, janitor—everything. They were interesting times. I remember that the door was so narrow I had to carry the bags outside and pack them in large wooden cases out on the sidewalk. At one time I was employing a staff of 125 workers.

THE FINISHING TOUCH

Bags are bought for two reasons—because they hold things and because they look attractive. These girls are applying the second reason to the bags—beautiful lithographs

"NATURALLY the manufacturing developed into machine production. There were plenty of bag-making machines to be had, but none were adapted to making the new kind of bag I had devised. The big problem became to get a sack-making machine that would turn the bags out in one continuous roll. It took us 14 months before we got what we wanted. We had a special bag-making machine built in Philadelphia to suit our particular requirements.

"How many bags have you made and sold altogether?"

"More than fifty million. Our growth has been steady. In 1916 the Deubener shopping bag was nothing but an idea. In 1919 we sold nearly a million of them. We climbed steadily. In 1926 we sold more than one and a half million. This year we will be well over ten million.

"Production methods have kept pace with increased distribution. In the beginning we bought our paper bags in small quantities ready-made. Last year we bought 29 carloads of paper. Whereas we used to buy cord in one-pound balls, now we buy it ready-cut in carload lots. We used to send out the bags to have our name printed on them; now we have our own printing department. Instead of cutting out pictures from magazine covers, as we did to decorate the first few bags, we now buy ten million beautiful lithographs a year."

"WOULD you say that the shopping habits peculiar to the American public have made your success possible?"

"No, I think that the shopping habits responsible for our bag's success are world-wide. As a matter of fact we have sold our bags to dealers in nearly every civilized country on the globe. Not long ago we licensed a firm who opened a branch factory in England. Naturally, we have taken out patents in the leading countries of the world."

"What about competition?"

"There is plenty of it and it keeps us constantly on our toes. We have managed to develop, however, by constantly giving a better bag and better service. We have worked out labor-saving machinery to reduce costs; we have been always on the alert to improve the appearance of the bag and make it of stronger paper. We now have ceased calling it a paper bag and call it a 'leatherlyke' bag because of the unique appearance we have been able to give it."

"But what you seized was an unusual opportunity for a useful invention, was it not?"

"Not at all. There are more opportunities for profitable invention today than there were in 1917 when I made mine. The inventor, of course, must proceed logically. From my experience, I should say that the first thing to do is to make sure that your idea is practical. Then find out that there really is a public demand for it. Next, select a reliable, experienced patent attorney and apply for a patent. If you have ample finances, sufficient business experience and all the other necessary qualifications, then the way for you to make the most money out of your invention is to do your own manufacturing and selling, for you will be more enthusiastic about your own invention than anyone else would be and you will work harder. If you lack sufficient business ability or finances, then try to make some arrangements with a reliable manufacturer on a royalty basis.

"THERE is nothing wonderful or mysterious about business or making money from the right kind of an invention. Successful business is nothing more than an accumulation of a lot of little policies carried out intelligently, carefully, continuously and energetically. There are many inventions that are impractical, of course, but if you have something the public needs, then plain common sense and hard work will bring your reward. At least, we have found it so."

"Mr. Deubener, throughout our conversation you have been saying, 'we.' Whom do you mean when you use the word 'we'?"

"Why, my partner, Mrs. Deubener and myself. We are partners in business as in everything else. Our business wouldn't be what it is today without her help. I didn't mention it before, because I thought it was self-evident, but a fine, 'A Number One' wife is a valuable asset to every inventor and business man."

CHAIN STORES SELL MILLIONS

The first sale to the "five and ten," was 25 bags. Today a picture like the above might be taken in any city in the country

Conservation or Extinction?

How Two Creatures, Living at the Earth's Antipodes, Were Blotted Out of Existence by Human Greed

By Dr. LEON AUGUSTUS HAUSMAN

WHAT is it to be "as dead as the dodo?" It is to be dead specifically, as the scientist would say, as well as individually. As a general thing, in animal and plant life, individuals die, but the species, or "kind" remains, represented by other individuals. When, however, the individuals making up a species keep growing fewer and fewer, and finally die out altogether, then that particular form of life is dead specifically—there are no more of its kind left—it is extinct. As long as there are some individuals of a species living, there is the chance that by surrounding these forms with the favorable conditions for their life and living they may be induced to increase again. This is what we mean by conservation, used in its present-day sense. Conservation, from a biological viewpoint, goes farther than merely an attempt to preserve what is valuable; it has no less an object than to promote its growth and expansion. The inevitable corollary of conservation is increase; the inescapable consequence of prodigal use is extinction.

IN all the realm of the history of living things we can find no better illustrations of the obliterative effects of unrestrained human greed upon vigorous living things, than in the melancholy stories of the extinction of two of our most remarkable forms of life; the dodo of Mauritius, and the passenger pigeon of North America. Think of it: two birds, one great in body, the other great in numbers, forever blotted out of human experience! And this within a comparatively few years; by a comparatively few people; for the gratifying of a comparatively dishonorable desire to glut the appetite!

The opening scene in the tragedy of the dodo begins about the year 1510, and is laid in the Indian Ocean, near the shores of Africa. Here there lies a small group of islands, of which Mauritius and Bourbon are the most important. It was on the former of these that there landed, in the year we mention, a party of Portugese navigators under one Captain Cornelius Van Neck.

Finding themselves in need of provisions and water for the ship, a small party had gone ashore, and soon returned in considerable excitement, bearing tales of a remarkable bird which they had found in large numbers —a bird quite unlike anything which they had ever seen or heard of in Europe. It was the famous dodo, and these were the first Europeans who had ever seen this curious bird. In a published account of his voyages, Van Neck gives some account of the dodo. It seems that the sailors had killed a number of these great birds with clubs, and had tasted their flesh. With the exception of the breast-meat they found it tough and very ill-flavored, and hence dubbed the birds *walckvogel*, or, plainly translated, disgusting birds.

NET FOR PIGEON SNARING

With such nets, and with guns, clubs, long poles, and sulfur pots, thousands of pigeons can be taken and destroyed in a single night

The birds were often seen after this, not only by the Portugese, but also by Dutch sailors, and on the island of Bourbon as well as on Mauritius. Between 1610 and 1620 several live specimens were brought into Europe by travelers as curiosities. There were two species of dodos; the Mauritius dodo and the Bourbon dodo. The former, shown in the photograph of a contemporary drawing, was a bird about the size of a very large turkey. Its color was ashy gray, with a bluish cast, lighter on the throat and upper breast. The short, stubby wings were useless for flight, and bore but a few light yellow feathers, as did also the tail.

The most unusual feature about the dodo was its enormous beak, an organ which served it well in tearing vegetation which comprised its food. The Bourbon dodo was a much more handsome bird, with its silvery white plumage and yellow wings. The bill and feet of this species were of a brilliant yellow, and altogether it must have been, despite its grotesque proportions, a strikingly beautiful natural element in the scenery of the island.

In habits the dodo was supremely torpid, hence its Dutch name, a corruption of the Dutch *dodoor*, a sluggard. So languid, both of perception and gait, were these birds, that they could be easily overtaken by sailors and killed with clubs, as the drawing also shows. In this manner many thousands were killed during the 16th and 17th centuries, and salted down by sailors for food on long voyages.

The cry of the dodo was humorously out of proportion to so huge a bird, and was likened to the petulant cry of a gosling. The last records of the dodo show that it survived until the year 1861. Since that time no one has ever seen the unfortunate bird.

THE causes of its extinction are not hard to determine. In the first place the dodo was not a rapid or prolific breeder, laying but a solitary egg at a time, on an unprotected nest of grass on the ground. Before the coming of the Portugese, the species had been able to maintain itself, but with the advent of the sailors, who killed many of the adult birds with clubs, its numbers began rapidly to diminish. What the sailors began in the way of extermination, some pigs which had been liberated on the islands, completed. These, rooting about, discovered that the dodo eggs were excellent food. Soon the pigs and their progeny succeeded in destroying the nests and eggs of the dodos to such a degree that any natural increase of the species was checked, and soon so lowered that gradually the dodo was forced to give up in despair. So it bowed itself off the stage of life and took up its rôle as a mere record in travelers' note-books, or as a stuffed and mounted specimen in a museum case! Fragments of dodos are preserved in several European museums.

"Could the dodo have survived, and have become the object of careful protection, there is the probability—considering its unsuspicious and adaptable nature—that it might have been domesticated and transplanted to many

other climes and become of value for its flesh and feathers.

In 1914 there died, in the Zoological Gardens in Cincinnati, Ohio, what is believed to be the last passenger pigeon. It was a female, and the last of a race of birds which had once filled whole forests of our continent with its cooings, and had darkened the sun in flocks of millions upon millions of individuals. And this no longer ago than many a man now living can remember! What has happened to these vast legions of birds? Ask the dodo. It might tell you that after it had found its way into the realm of extinction via the human stomach, the passenger pigeon came following after, over the same road!

Our American ornithologist, Wilson, writing about 1808, recorded that a single flock of passenger pigeons which he had observed in Kentucky must have numbered over two billion individuals! This was the careful estimate of an ornithologist, not the exuberant statement of an untrained and excited onlooker. Enormous flocks of these beautiful birds, winging their way to their feeding grounds, sometimes stretched out over the sky in dense columns from eight to ten miles in length. Careful observers reported columns of these birds flying at great heights, and taking hours to pass by a given point. Some flocks were over a mile in width, and were estimated to be at least (with very few breaks) over a hundred and fifty miles long.

The passenger pigeon (of which there are many mounted specimens to be seen in our museums and institutions of learning) was one of our most beautiful American birds. Its total length was some 16 or 18 inches, including its tail, which was composed of 12 tapering feathers. In general its upperparts were a bluish slate color, with the loveliest metallic reflections of purple, green, and metallic orange and yellow. The underparts were a rich vinaceous tint, fading to whitish on the abdomen. The tail was broadly tipped with white. The female was duller with more olive-brown and gray. The bird which today most closely resembles it is the mourning dove, and is often mistaken for its now extinct relative. The passenger pigeon formerly ranged from Hudson Bay to the Gulf of Mexico, and from the Rockies to the Atlantic. It seldom found its way to the Pacific Coast, though stragglers were often seen there. It was most abundant east of the great plains.

Its breeding places were forests, in which it constructed in the branches of trees its frail platforms of twigs upon which the two eggs were laid. Several broods were reared during the spring. In the Mississippi Valley, flocks of these birds during the nesting season covered tracts of forest over 200 miles square, and often more than 100 nests could be counted in a single tree!

WITH the gathering of the birds to nest at the beginning of the nesting season, there came together for the purpose of slaughter multitudes of men and boys from the neighboring country-sides. As the birds alighted in vast flocks upon the branches of the trees the carnage was begun. With clubs, long poles, guns, nets, pots of burning sulfur, traps, and other implements of destruction the people fell upon their feathered breathren with fearful havoc.

Tons of the bodies of their victims were gathered together. Some were used for human food. Loads of them went to feed pigs. Others were used for fertilizer. Countless thousands were left to decay where they fell. Thousands of men and boys, known as "pigeoners" followed the flocks of birds about, and sent the birds away to many distant points by the ton. In the night the roosting birds were blinded by lanterns and then while bewildered by the light were knocked from their perches with long poles and stuffed into bags. Pigeon meat was cheap, and it was salted down for winter use. Live pigeons sold in city markets for four cents apiece!

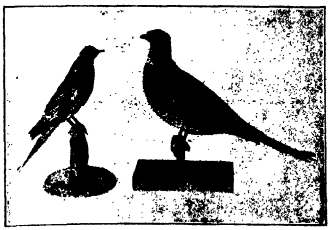
It is interesting, and very significant, to note that while the white men were indulging in this reckless slaughter, the Indian tribes, which gathered together at the nesting season for the purposes of social hunting and the augmenting of their winter food supply were exercising a caution and a foresightedness which might be said to be the first conservation program to make its appearance upon our continent. For the Indians took merely the young in the nest, and even then did not deplete whole areas as did the whites.

Attempts to legislate against the wholesale and unregulated butchery of the wild pigeons were laughed down. No one thought it possible that a bird represented by such enormous numbers, and rearing two, three, and even four broods a year, should need protection by law! However the numbers of the pigeons grew steadily less, and in 1881 pigeon hunting, as a business, died out. The ornithologist, Bendire, writing in 1892, at length said "....it looks now as if their total extermination might be accomplished within the present century." The flocks were now scattered; the birds no longer bred together, but in more or less isolated pairs. Soon they became extremely rare. Since 1898 there have been no well-authenticated and unquestioned records of their capture. A female, said to have been shot at Bar Harbor, Maine, in the summer of 1904, and to have been mounted by a taxidermist in Bangor, has not been traced and identified.

Does not this tale of millions of birds in 1800 and not one in 1915 bear the same warning as does that of the dodo? Both were valuable elements in the natural economy; both were numerous; both were sought by man for the same purpose; both were slaughtered in the same unrestricted fashion; and both are no more.

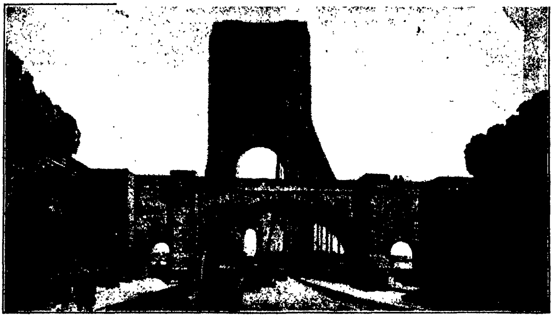
THE GOOD-NATURED BUT SLOTHFUL DODO

In the background of the picture can be seen sailors killing the birds with clubs and carrying them to the ship to be used for food



THE LATE PASSENGER PIGEON

The mourning dove, left, one of our common wild birds, is often mistaken for its relative, the now extinct passenger pigeon



NEW JERSEY ENTRANCE TO THE HUDSON RIVER BRIDGE

The Hudson River bridge, whose under side will be 200 feet above the river, strikes the perpendicular cliffs of the Palisades and passes through in a 50-foot cut, spanned by this monumental arch which forms a fitting portal to the bridge

A Monumental Bridge

New York Will Soon Possess Another "World's Greatest" in the 3500-foot Suspension Bridge Across the Hudson River

THIS is an age of superlatives, and it would sometimes seem that the ultimate word of praise has been bestowed when we are able to say that something is the longest, highest, fastest, biggest, et cetera, thing of its kind. So we are quite in the fashion in starting this article on the new Hudson River bridge, if we say at once that its span is so long, and its towers are so high, that it will be incomparably, on completion, the greatest suspension bridge, or bridge of any kind, for that matter, in the world.

The bridge is being built to provide greatly needed transit facilities between the northern part of Manhattan Island, the Bronx, Long Island, and New Jersey. At present, freight and passengers make the transit of the North River either by ferries or tunnels; and although the ferry service is excellent, and four separate tunnels, including the vehicular tunnel, are, or soon will be available, these are not sufficient to meet the present conditions, to say nothing of the vastly increased travel of the future.

The urge for a great Hudson River bridge has long been felt. It must now be some 40 years since that widely known bridge engineer, Gustav Lindenthal, startled the world with his bold proposition to bridge the Hudson with a great suspended structure, having a central span of about 3200 feet. Some years ago, due to the movement uptown of the centers of business activity, the site for the crossing was moved from 23rd Street to 59th Street.

The latest plans for this structure call for a bridge with a floor width of about 230 feet and a capacity for 16 lines of motor-car traffic on the upper deck and 12 tracks for steam and electric trains on the lower deck. The scheme contemplates a large railway terminal at the Manhattan end of the bridge, and an elevated structure crossing Manhattan at 59th Street, designed to give direct motor-truck and rapid-transit connections with Long Island.

VARIOUS considerations, including the great cost of the enterprise, have delayed its construction; but there is no question but that the rapid growth of the metropolitan area and its freight and traffic demands will ultimately secure its completion.

Meanwhile, the Port Authority, acting under the mandate of the states of New York and New Jersey, has undertaken the construction, between Fort Washington and Fort Lee, of the great bridge which forms the subject of the present article. Its capacity will be much smaller than that of the proposed 59th Street bridge and its estimated cost of 50,000,000 dollars is of course proportionately less.

The bridge is to be built in two stages. When the first stage is completed, it will provide a single upper roadway for four lines of vehicular traffic and two passenger sidewalks. It is estimated that 50,000,000 dollars will cover the cost of this. Later, to meet the growth of population and travel, the upper or roadway deck is to be widened and a lower platform will be provided. The bridge, as thus finally completed, will provide for eight lines of vehicular travel and footwalks on the upper deck and for four or more lines of rapid transit tracks on the lower deck. The whole cost of the structure when finally completed will be about 75,000,000 dollars.

Work will be done, as we have said, under the direction of the Port of New York Authority, of which Geo. S. Silzer, former Governor of New Jersey, is Chairman. O. H. Ammann, formerly chief assistant engineer to Gustav Lindenthal in the design and construction of the Hellgate bridge and the design of the 59th Street Hudson River bridge, is the bridge engineer responsible for the design and construction of the present structure. He is assisted by Wm. H. Burr, Geo. W. Goethals, Daniel E. Moran, and Leon S. Moisseiff as consulting and advisory engineers.

It will be of interest here to touch upon the history of long-span bridges. The first and most notable of these is

the Brooklyn bridge, completed in 1883, a suspension structure with a clear river span of 1596 feet, carried by wire cables. Seven years later was built the famous cantilever, Firth of Forth bridge in Scotland, which includes two cantilever spans each 1710 feet in length. This dimension was exceeded when there was opened, in 1917, the St. Lawrence cantilever bridge, near Quebec, with a central span of 1800 feet. Other notable bridges are two suspension structures across the East River, (the Williamsburg bridge with a 1600 foot span and the Manhattan bridge with a 1470 foot span); the Bear Mountain suspension bridge opened in 1924 with a central span of 1632 feet; and the Camden bridge across the Delaware, with a span of 1750 feet. This is today the longest suspension span to be found anywhere in the world.

THE Hudson River bridge will have a central span of 3500 feet, which is just twice the length of the Camden span. The total length from anchorage to anchorage will be 4800 feet, each of the shore spans being 650 feet in length from the main supporting towers to the anchorages. Necessarily, dimensions and weights in a structure of this vast size will run to large figures. The height of the towers above water will be 650 feet. The weight of the suspended structure will be 120,000 tons. The total maximum pull on the wire cables will be 135,000 tons, and, if eyebar cables are used, it will be 165,000 tons. The vertical load on the towers, if eyebars are used, will be 140,000 tons, and with wire cables it will be 115,000 tons. The total load on the foundations will be 350,000 tons.

To resist the pull of the cables on the New York side, there will be built a vast, concrete anchorage weighing 370,000 tons. Finally, the total weight of the entire structure, including anchorages, towers, cables, floor system, et cetera, will be about 1,000,000 tons. These are enormous figures; but we must remember that they are for the two-deck structure as finally completed.

To come down to details, if eyebars are used, they would be made up in four cables each consisting of 48 eyebar chains, consisting of eyebars two inches thick by 16 inches deep and 60 feet or more in length. If wire cables are used, there will be four cables, each 36 inches in diameter. Each cable will be made up of 28,500 number six galvanized steel wires laid parallel, bunched snugly together by hydraulic pressure, and wrapped with a steel-wire protective covering.

That the cables will have a generous margin of strength is seen when we remember that the pull required to break a single wire is 6000 pounds, and that the pull on one wire, when the bridge is loaded to its maximum capacity is only 2300 pounds.

It will be understood that in a bridge of this great size the principal stresses are those due to the weight of the structure itself. So great is this, that the weight of the live load consisting of motor cars, trains and pedestrians is relatively small. This is not true of shorter suspension bridges, for in these, the weight of a moving train is in much larger proportion to the weight of the bridge.

SPANNING THE HUDSON

Perspective of the monumental bridge which will sweep from shore to shore in one unbroken span of 3500 feet

When, several decades ago, Roebling built an 800-foot suspension railway bridge at Niagara, it was realized that as a train advanced over the bridge it would cause a local sagging of the cables so that a wave of depression would mark the transit of the train. This was overcome by incorporating a deep truss with the roadway. The Hudson River bridge, however, is so heavy, that a comparatively shallow truss will suffice to prevent vertical distortion of the roadway. It is claimed, and we think with good reason, that the small depth of the truss adds greatly to the artistic or esthetic appearance of the bridge.

Construction in two stages will conduce to the early opening of the bridge, and it will be necessary to find only 75 percent of its ultimate cost for the completion of the first stage.

As thus carried out, the bridge will consist of the two anchorages, the complete cables, and the two 650-foot main towers, which will be built of steel. The single deck will provide, at first, for four lines of vehicular traffic and two passenger footways. When the time comes to provide for rapid transit tracks, a lower deck will be constructed on the level of the lower chord of the stiffening truss. To provide for this additional load, and to enhance the appearance of the structure, the towers will be strengthened by enclosing the original steel structure of the bridge in a mass of reinforced concrete. The towers will be faced with granite.

ON the New York side, the anchorage will consist, as we have stated, of a mass of granite-faced concrete of sufficient weight to resist the enormous pull of the cables. The approach to the bridge on this side will consist of massive masonry arches finished in cut granite, as shown in our general view of the bridge. On the New Jersey side, the floor of the bridge strikes the great natural wall of the Palisades at a point about 50 feet below its crest, and the roadway will pass through the Palisades in a cut of this depth.

In order to preserve the crest line of the Palisades, a masonry bridge, consisting of a central arch for vehicular traffic and two flanking smaller arches for pedestrian traffic will be carried across the cut. It will be of massive appearance and will form a fitting portal for the approach to the great bridge on the New Jersey side. The anchorages for the cables will consist of a tunnel driven for 250 feet into the solid rock of the Palisades, through which the cables will pass to take hold of a massive steel grillage embedded in the rock. These tunnels will subsequently be filled in with concrete, the whole work thus forming a thoroughly protected and permanent anchorage, secured forever against any accident, or deterioration due to the action of the atmosphere.

The architectural features of the bridge have been taken care of by Mr. Cass Gilbert who designed the Woolworth tower and many other monumental buildings in this city and elsewhere. He has endeavored, and we think very successfully, to treat the

VIEW OF THE HUDSON RIVER BRIDGE LOOKING UPSTREAM

The longest existing suspension span today is the crossing of the Delaware between Philadelphia and Camden, whose central span measures 1750 feet between towers. The span of the Hudson River bridge will be exactly twice as long, measuring 3500 feet. Height of towers 650 feet

great anchorages, and particularly the enormous towers, with that simplicity of line and sparing use of decorative details which a structure of this size demands.

Each tower will present the appearance of a single monolithic mass pierced by two wide arches, one below and one above the roadway. The cables will pass through small arched openings near the top of the towers. The vast proportions of these structures will be realized when it is stated that it would be possible to place a 17-story office building within the major arch over the roadway.

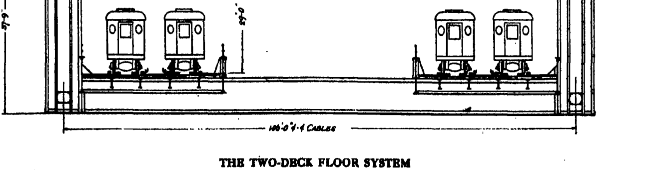
On the New Jersey side, good foundation rock for the tower is found at about 100 feet below water level. The excavation for this foundation will be done by means of two open cofferdams. Upon the New York side, rock of excellent bearing quality is found at the surface.

The Hudson River bridge stands in an exposed position and it will be subject at times to winds of high velocity. To resist the wind pressure, there will be a horizontal wind truss worked into the upper floor of the bridge; but the principal resistance will be found in the enormous inertia of the bridge itself. This is so great that if the bridge were struck by a furious gust, such as might come in a thunderstorm, its force would be spent before the bridge moved appreciably in response to it. The high improbable *continuous* force of a strong wind would push the center of the bridge not more than 12 to 18 inches away from normal.

IN the design, a maximum lateral swing of 3 to 5 feet has been provided for. There will be vertical distortion, however, due to the fact that the steel cables will shorten up about four feet in cold weather and will expand in hot weather, with the result that the center of the bridge will be about five feet higher on a cold day than on a hot day.

Finally, there is the question of future traffic over the bridge. It is believed that in the first year (1932) after the bridge is opened, the number of vehicles which will use the bridge will be 8,848,000 and that they will carry as passengers 18,898,000 people. The number of pedestrians is estimated at 1,413,000 and the number of buses which will use the bridge is put down at 497,000. It is believed that about 30 years later, in 1960, over 16,000,000 vehicles will carry some 50,000,000 passengers over the bridge, that among the vehicles will be 1,616,000 buses, and that the number of pedestrians will be over 3,000,000.

Outside of constructing the bridge is the problem of building adequate highways on the New Jersey side to carry away from the bridge-head and distribute the heavy traffic which will flow over the bridge. Many of these highways do not now exist. None of them have at present the capacity required. This means that they must be built *de novo*, or must be materially widened. It is estimated that the road-building program confronting Bergen County within the next decade will cost ten millions of dollars. There is no such problem at the New York end.

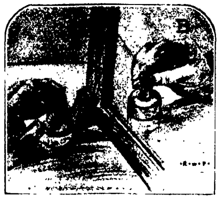


THE TWO-DECK FLOOR SYSTEM

The floor is hung by pairs of steel-wire suspenders from four 36-inch wire cables. On the upper deck is accommodation for eight lines of motorized traffic. This deck is carried on transverse floor beams about 10 feet deep, spaced 60 feet apart. Lower deck carries four rapid transit tracks

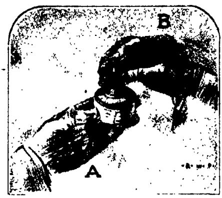
SOMETHING TO FIGURE OUT

FIGURE 1: *Why is image C perverted and the small drawing on chiffonier inverted?*



THE NEXT STEP

FIGURE 2: *By turning the hand as shown a right-hand reflection is obtained*



COMBINING THE TWO

FIGURE 3: *The hand of the first sketch is combined with the image in the second*

◄ A SIMPLE "DODGE"

FIGURE 4 *Thus far we have obtained the picture as it appears to ourself; now we must do to it something which will make it look as it looks to the other fellow. A second mirror is therefore hunted up and placed as shown at D*

THE FINAL RESULT ►

FIGURE 5: *The image produced with the extra mirror (see E of sketch at left) is combined with image C of the first sketch, and we come out with just what we originally sought—the pose, not as it looks to us, but as it appears to the other fellow*

A Simple Study in Optics

By RUSSELL W. PORTER

"O wad some power the giftie gie us,
To see ourselves as others see us!"

"All right," you say, "Nothing easier —go and get the looking glass...... There you are, just as others see you, on the other side of the mirror."

But the fellow I see in the looking glass has become so familiar that I forget the fact that he is not like me at all. It is only when we try on our new suit of clothes at the tailors, where he rigs up two mirrors, that we see ourselves as we actually are.

For example, your left eye in the glass doesn't look like a left eye. When you wink your left eye the fellow winks back with his right. Twiddle your right thumb: he replies with his left.

I referred the above statement to my daughter for verification. "Sure," she said, "I know that. Whenever I pin a flower on my dress I see which side it looks best on in the glass, and then I pin it on the other."

So that image on the other side of the mirror is very much like the animal that lived on a hill side which was so steep that his right legs became very much longer than his left ones, and the only way by which he could elude his pursuers was to turn himself wrong side out. By doing this his right legs became left and his left legs right, and he could travel in the other direction.

Now what has all this to do with science? What is it doing in the columns of the SCIENTIFIC AMERICAN? Well, nothing; except that it illustrates a fundamental property in optics, namely, that a reflected image is "perverted," as the highbrows say—or turned around. Not inverted, for the fellow is still right side up. And herein lies an application of light that I, as an artist, find very useful.

WHEN a person wishes to put an idea over, so that the other fellow sees it as he does, there is nothing in the vehicle of words that compares in realism and clarity with a sketch or drawing. Inventors (and their draftsmen) are sometimes hard put to it to express their ideas on paper. Here is an illustration:

Suppose I wished to show you (and you were not with me) some particular way of uncorking a bottle. I, being a draftsman, attempt the drawing. Of course the photographer could be called in, and that would settle it right away. But that procedure would take away most of the fun. I have only two hands and one of them is busy with the pencil. The left hand must do all the posing. But how? Simply by means of mirrors and multiple reflections, as follows:

If I want my friend to see the manner of uncorking the bottle as I myself see it, the left-hand pose is drawn directly, like A, Figure 1. Then, by looking in one of the mirrors I see my left hand, but it is a perverted image of it, and looks like a right hand. By getting a sidewise view and assuming the right-hand pose, this reflected image B, Figure 2, is drawn, and we get the view in the finished drawing, that is, Figure 3 as seen by the person himself who is doing the uncorking.

To present the picture as seen by the other fellow, the procedure is not so simple. The left hand is first drawn by reflection, as seen at C, Figure 1. It looks like a person's right hand as you face him. My wife's hand glass is next requisitioned and set up as at D, Figure 4.

Now in the larger mirror one can see the hand glass, and in the hand glass is an image E, Figure 4, twice reflected, which has all the appearance of a person's left hand as seen when you face him. And it only remains to combine the two drawings C and E to have the complete sketch, Figure 5.

THE RECORDING INSTRUMENT ▲

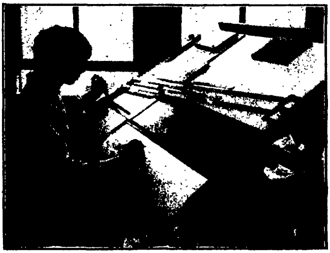
The record of the notes and tone coloring ... taken down on the right-hand sheet in the form of pencil marks. The dynamic record, on the left, comes off the instrument without anything showing on the sheet. After it is put through a development process, marks indicating the measurement appear. These marks are then identified into pairs which are measured by a scale divided into one hundred and twenty parts; each part represents one-tenth of the difference in loudness discernible by the average ear. After this is done the measurements are transferred to the note sheet giving a figure at the beginning of each note which tells to an unbelievable accuracy just how loud that note was struck by the recording artist. The recording instrument is connected by means of electrical circuits to the recording piano located in another room where the artist plays the original music

▲ EVERY DETAIL IS MEASURED

Here the myriad dots and lines of the recording are examined and measured in process of translating them i[illegible] perforations which control the reproducing mechanism in the piano, and give a performance which clearly possesses even the emotional qualities of the original playing. Operators examine and measure every detail set down in the recording of a person's playing. One of the most interesting operations is the analysis of the tone quality which is made possible by indications showing the speed with which the dampers [illegible] down [illegible] tions, which cause their tones to sing through from one harmony to the next, thereby giving effects identical with those which the original artist contrived to put into his playing

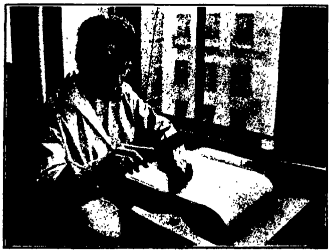
WRONG NOTES ARE ELIMINATED

A painstaking checking with the sheet music eliminates wrong notes which were accidentally struck by the pianist



TRANSFERRING MEASUREMENTS

Unraveling the maze of figures in a dynamic record and transferring them to the roll is made extremely simple by an ingenious device



HAND PERFORATING PILOT HOLES

Hand-perforated holes at each end of the line indicating the position and duration of the notes guide the automatic stencil-making machine

Recording the Soul of Piano Playing

A RECORDING instrument, lately perfected by the Ampico Research Laboratory, accurately reveals the physical basis of those finer emotional qualities which mark the inspired performances of the great masters. A record taken on this instrument of the playing of an everyday pianist clearly shows the mediocrity of his performance as compared with that of one of the foremost great artists. That lovely liquid singing quality of tone—which is so rarely heard even in the great recital halls; that bel canto which subdues an audience to the point of making them regard the dropping of a pin as a misdemeanor; and a cough as a states prison offence; and other effects, heretofore regarded almost as manifestations of the soul of the artist, are being analyzed for mechanical reproduction through the record music roll. This delicate recording instrument measures accurately the length of time it takes the hammer to travel the last eighth of an inch before it strikes the string, and from this measurement the exact loudness of the tone produced can be easily calculated, 416 hundred-thousandths of a second being required to produce the softest note and 51 hundred-thousandths for the loudest. About 60 times more energy therefore is expended in striking the loudest note than when producing a whispered pianissimo. Some

FIRST HEARING OF RECORD

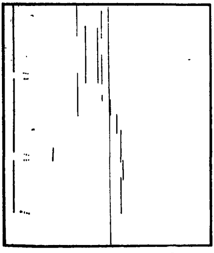
The first time a record is heard is when it comes from the automatic stencil-making machine. With only pilot perforations at the beginning and end of each note as guides, this machine has simultaneously cut a trial and a finished stencil. The stencil is three times the length of the trial record. An operator who is a finished musician takes the record at this stage and carefully examines every detail of the performance, checking up the result of the various stages in the long process of its completion. After the corrections indicated during this rigid inspection have been made, the record is an exact duplicate of the artist's playing, even in the smallest detail of light and shade, and is now ready for the artist to hear. Upon hearing the record, the artist becomes his own critic and if any further change is to be made, it is in deference to his wish to alter his performance

AUTOMATIC STENCIL MACHINE

This remarkable piece of automatic mechanism, which all but thinks, took more than five years to design and construct

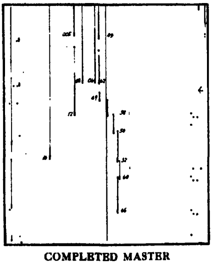
STENCIL CHANGES

A special table over which the record and the stencil pass at the right proportionate speeds facilitates the making of any changes in the stencil which the artist has indicated in the record after hearing its performance. Usually the changes suggested by an artist have to do with dynamic where he accented a note too much or too little or where one phase had too much or too little contrast with another. He seldom touches the rhythm or the tone coloring. In a dance record, the rhythm is automatically checked and corrected in the stencil machine. After alterations are made the machine makes duplicates from this stencil and these in turn are used in the manufacture of the finished music rolls used in the reproducing piano. The actual music-cutting machines are duplex, cutting 30 rolls at a time in two groups of 15 each at the rate of three and one-half feet of finished record per minute of operation



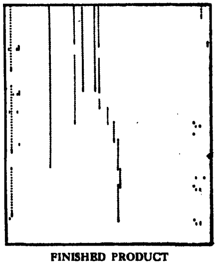
ORIGINAL RECORDING

Here are shown the pencilled lines of the notes, pedaling, and speed of the dampers



COMPLETED MASTER

It has the dynamic figures, tone coloring extensions and expression perforations



FINISHED PRODUCT

The record as it comes from automatic stencil machine, ready for first hearing

Revealing Idiosyncrasies of Artists

interesting side-lights are shown in the playing of great pianists by this super-accurate method of recording. One artist who produced an exceptionally beautiful quality of singing tone was found to co-ordinate his hands and pedaling to the almost incredible accuracy of one fiftieth of a second. We sometimes hear a performance which sounds perfect. Apparently there is not a flaw existing in the playing. Records of such performances when analysed sometimes reveal unbelievable faults. One example, which to the ear showed the most remarkable control of dynamics, beautifully graduated melody, and an accompaniment played with almost inaudible softness and smoothness, revealed when submitted to the tests of an uncompromising measuring machine, a grossly faulty rhythm in the accompaniment. This shortcoming was not discernible in listening to the playing because the accompaniment was too soft to define the positions of the various notes. The records measure technical ability with uncanny accuracy. The marks of the pencil points of this soul-searching machine show exactly the control the pianist has over his fingers; whether his dynamics are nicely balanced or ragged; if his tone is good or bad; and even whether his playing has feeling or is cold. The performance is figuratively put under a microscope.

What is New in Radio?

Manufacturers Turn to the Light-Socket Receiver—Many Improved Devices

By ORRIN E. DUNLAP, Jr.

RADIO this season is in a transition period. The autumn styles reveal a distinct trend from the battery-operated receiver to the light-socket set, which dispenses with all batteries and takes its power from the house-lighting mains. A few circuits of this type appeared on the market last year, but this season many more manufacturers have introduced batteryless equipment, because of the further development of alternating-current tubes and improved rectifiers. The filaments of the new tubes obtain their source of power from the light socket through a small step-down transformer, while the rectifier tubes convert the alternating to direct current at suitable voltages to replace "B" batteries.

THE round dial, which was the standard tuning scale up to about a year ago, has been eliminated entirely from the majority of new sets. Most of the manufacturers have adopted the drum control arrangement, featuring a tiny "window" or slit in the panel, through which the wavelength figures appear as the stations are tuned in. The single control for tuning is extremely popular on the new models. A small knob is used generally to manipulate the drum-tuner, which adjusts the variable condensers arranged on a single shaft, thereby affording simplicity in tuning.

The table models, on an average, are smaller and more compact than have been previous instruments. However, each manufacturer usually supplements the smaller sets with more elaborate console cabinets with the loudspeaker built in, while some apparently favor the external loudspeaker arrangement. In exterior appearance, the table models have a marked similarity, probably due to the fact that there cannot be a wide variety of arrangements of a single tuning control. Cabinets in general are of the slanting panel design, so that light will more easily fall on the tuning "window," usually placed in the center of the panel. Some of the sets feature pressed-steel chassis upon which the various parts of the circuit are firmly mounted, with tubes, transformers and coils shielded in metal compartments.

FLEXIBLE RECEIVER

This Crosley set is designed so that it can be transferred without changes from a standard table model cabinet to a console. A screw driver is the only tool necessary for making the change

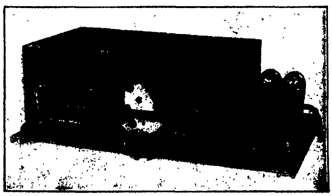
In the loudspeaker field the cone predominates. The horns are not as plentiful as they were several years ago. They are vanishing as did the horn of the early phonographs. Some of the disks have plain faces, while others have a decoration of some sort.

A NUMBER of cone reproducers are built in small cabinets to match various furniture designs. Others are drum or clock-shape. One novel loudspeaker of the cone type is built within a library globe, hinged at the center on its bronze pedestal, so that, by tilting back the upper half or closing the top to complete the sphere the volume of sound can be regulated. It is pointed out that this design gives the radio fan a handy map on which he can locate broadcasting stations or trace events that are broadcast, such as the progress of transatlantic airplane flights.

Radio set owners desirous of converting their present battery-operated receiver into one which functions in connection with the light socket will find a large assortment of "B" eliminators; trickle chargers with storage "A" batteries; also combination "B" eliminators and power amplifiers, the output of which

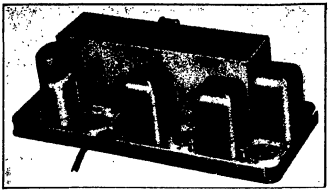
DRUM CONTROL TUNER

Chassis of the Workrite receiver, showing how the condensers and coils are shielded by means of metal cans, thus eliminating many undesirable effects. Tuning is done by a single control



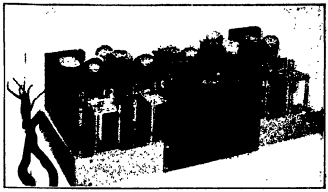
COMPLETELY SHIELDED

Metal cans enclose all of the essential parts of this Stewart-W set, affording complete shielding. Note the novel lever arrangement that is used in order to effect single control



THE "BANDBOX" SET

This is a rear view of the receiver illustrated in the center of the opposite page. Every part of it is completely shielded



SINGLE CONTROL

One of the new styles in radio designs, in which are featured binocular coils which, with the other parts, are on a metal base

can be regulated from a whisper to volume sufficient to fill a large auditorium with minimum distortion. These combination units plug into the circuit after the first audio-amplifier stage and therefore can be utilized to excellent advantage even with a two-tube set. Most of the current-supply apparatus employs new and improved rectifier tubes and in several instances the devices dispense with "A", "B" and "C" batteries by supplying the current to the receiver direct from the house lighting mains.

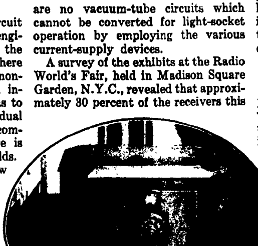
SIX and seven tubes in the circuit are popular numbers. The engineers have been careful to shield the tuning coils in most cases so that there will be no interaction to produce non-selective tuning or loss in signal intensity. Some have gone so far as to encase each coil in an individual cylindrical metal box, and each complete tuned radio-frequency stage is protected by rectangular shields. Several of these sets use the new alternating-current tubes and operate in direct connection with the light socket without the necessity of current-supply accessories.

The tuned radio-frequency circuit is most generally employed, and there are very few designers who have not taken advantage of a power tube in the last audio-amplifier socket as a means of improving tonal quality. There seems to be a tendency this season to get away from the external loop. Wherever loops are used they are usually advertised as "concealed," because it is said that housewives nine times out of ten vote against a receiver equipped with a visible loop. They say that it is not decorative and is not attractive in a living room.

It is contended that the majority of people have never installed a radio set in their homes because they do not want to bother with battery replacements and charging. Now, the manufacturers say that the light-socket receiver is here and that 11,928,060 homes wired for electricity, but without radio, can be equipped with foolproof sets. It is estimated that 6,500,000 homes have radio sets. The figure for 1930 is placed at 9,000,000.

The fact that numerous styles of light-socket receivers will be introduced this season does not mean that there will be no new sets designed for battery operation. There are plenty of high-class receivers built to perform with batteries or battery eliminators. Neither does the appearance of new alternating-current tubes mean that all sets now in use are obsolete. There are no vacuum-tube circuits which cannot be converted for light-socket operation by employing the various current-supply devices.

A survey of the exhibits at the Radio World's Fair, held in Madison Square Garden, N.Y.C., revealed that approximately 30 percent of the receivers this



NEW RADIO STYLE

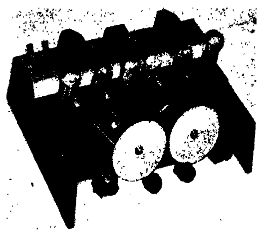
The construction of this new Splitdorf six-tube receiver clearly illustrates the trend in radio toward single control and the "window" method of reading the dial settings instead of the old type of round dials

season are designed to operate with alternating-current tubes. Seventy percent are battery operated. However, comment by the various exhibitors disclosed that most of them are in agreement that the percentage of electrical sets will increase from year to year, chiefly because of the millions of homes wired for electricity and the general desire of radio set owners to have light-socket receivers. Nevertheless, it is not anticipated that the evolution from the battery-operated set to the power-socket instrument will be as rapid as from the crystal to the vacuum tube in the early days of broadcasting.

The number of receivers of the table and console type is about evenly divided. The manufacturer who produces a console usually offers the same circuit in a table model or consolette. About 15 percent of the consoles have built-in cone loudspeakers, while 60 percent use the built-in horn with a long air column ranging from 50 to 70 inches in length. The remainder of the consoles are designed for use with external loudspeakers.

IN the loudspeaker exhibits this fall, about 75 percent are cones. Competition is now between the cone and the long air column composition horn, usually made of plaster of Paris. It is contended that the lengthy air chamber enables the horn to reproduce the lower notes equally as good as the middle and higher registers.

A review of the booklets and pamphlets, slogans and comments at the Radio World's Fair shows what is offered and what radio buyers this season can expect to obtain for their expenditures: "Unbelievable improvements in performance;" "A set priced for every pocket book;" "Battery-less radio;" "Stability as to patents;" "Durable, foolproof, shielded and sealed;" "—for the first time you can obtain from your house-lighting current steady, uniform flow of radio energy;" "Everybody agrees this is an electric set year;" "To connect a cheap loudspeaker to a fine radio set is like asking an opera star to sing through his nose;" "You can't get far away from the quality of the tube itself;" "This is an 'A. C.' year;" "Drum notes not only heard but identified;" "Totally shielded;" "Tubes for every purpose;" "Full rich tone;" "The world at your finger tips;" "Single control;" "A 'missing' tube in your set is even worse than a 'missing'



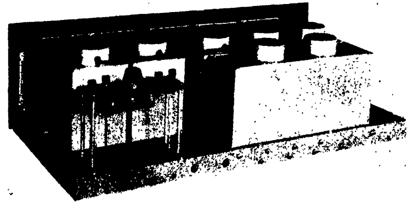
CHASSIS OF "COUNTERPHASE"

Some two years or so ago, an improved circuit known as the Bremer-Tully "Counterphase" made its appearance. Immediately it was seized upon by experimenters and subjected to exhaustive tests. The circuit proved to be highly satisfactory in many respects and has since been modified and changed slightly to give the best possible results. Here we see the entire set in its new form for the 1927-1928 season. It employs six tubes and has two tuning controls, the calibration figures of which are viewed through "windows" in the panel

cylinder in your car;" "Electric sets as different as electric light is from a candle;" "Always at full power;" "Extraordinary selectivity;" "A new achievement in power unit engineering;" "Harmonated reception;" "No hum;" "Wonderful range;" "Radio is better with battery power;" "Laboratory precision;" and thus one might go on and on describing the autumn styles, but these words of the men behind the apparatus give an excellent idea of what can be looked for in the new instruments.

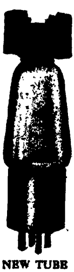
THE accessory field is the outlet for numerous novelties. One company is offering a permanent ground constructed of a solid copper sheet rolled in the form of a truncated cone. It is four inches in diameter at the base and three inches at the top. The height is twelve inches. It is filled with pebbly charcoal to hold moisture. The top is detachable. A 20-foot insulated copper wire welded to the "ground" is provided for attachment to the receiver.

A novel radio log listing more than 500 broadcasters in the wave band from 200 to 546 meters is being marketed by a Chicago concern. The log is published five times a year and is gummed for mounting on a revolving cylinder measuring about six inches long. It can be placed on top of the receiver or hung on the wall. Revisions are supplied on a subscription basis.



MODERN BATTERYLESS RADIO CONSTRUCTION

This Kellogg light-socket operated receiver uses alternating current tubes of low. The filaments are operated directly from stepped-down house curre[illegible]quired. Notice how all of the various parts and circuits are shielded from each other by metal cans



NEW TUBE

This is the type of tube used in the Kellogg receiver illustrated above. The filament terminals are at the top of the tube, while the connections for the grid and plate come out at the base to tips of the usual type. This tube can be plugged into a standard socket

A time-signal amplifier has been introduced to the autumn trade. It is called a "jeweler's time amplifier," consisting of a three-stage long-wave amplifier and detector completely encased in a copper shield with only the tops of the four tubes protruding. The unit is pretuned at the factory to the 112 kilocycle frequency used by the United States Navy's transmitter NAA at Arlington, Virginia, in radiating the time ticks of the nation's master clock located in the subterranean vault of the Naval Observatory at Washington, D. C.

The phonovox is an electrical pick-up designed to convert an ordinary phonograph into an electrical one, by utilizing the audio-frequency amplification and reproducer system of a standard radio receiver. The device is attached to the tone arm of the phonograph, while an adapter fits into the detector socket in place of the tube.

An instrument for reactivating and testing worn-out vacuum tubes has been introduced by a manufacturer in Massachusetts. The device operates from 110 volt, 60-cycle, alternating current and requires no batteries. Sockets are provided in which the correct voltages for testing, flashing and "cooking" thoriated tungsten filaments are automatically obtained without adjustments. It will test oxide-coated filaments too.

A new type of vacuum tube designed as an oscillator for short-wave transmission has been announced by a concern in New Jersey. It has an input of 300 watts and fits in the standard 50-watt tube socket. It will oscillate on a minimum wavelength of 2½ meters. As high as 2500 volts can be applied to the plate inasmuch as the plate terminals are at the top of the bulb, thereby eliminating danger of a short circuit in the form of a flash-over.

A New York manufacturer has introduced a cone speaker which can be utilized as a small table having a top 18 inches in diameter. It is made in two-tone mahogany with the cone mounted so that the wooden casing is used as the table top and sounding board.

An Indiana concern offers a star-shaped antenna said to be non-directional. It consists of a cast of aluminum ten inches across the tips and three-quarters of an inch thick. It is mounted on a ten-foot electric conduit pipe from which the star is insulated by a three-inch bar. The lead-in wire is taken off the center on the back of the star.

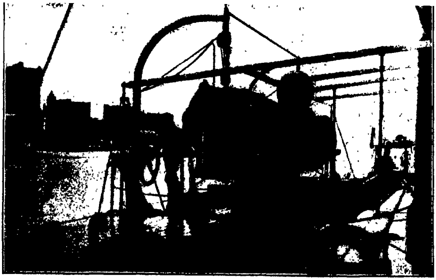
A Detroit manufacturer has developed an automobile bumper to be used as an antenna for radio reception in a motor car. By means of insulated laminated strips the bumper antenna is carefully insulated from the chassis of the car. A special clamp is employed in holding the bumper to insure good electrical contact. The ground or counterpoise contact is made to the body of the car.

Life-boats Made Safer

Dutch Patents Cover New Type of Construction

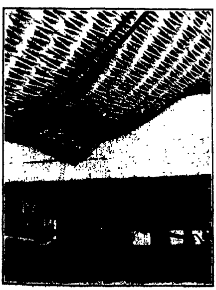
RELEASING THE BOAT

THE method of swinging this new life-boat away from the ship so that it can be lowered to the water is simplicity itself. A releasing lever, shown in operation here, drops the supporting chocks, leaving the boat free to swing on the davits. These safety life-boats are, as far as the inner frame-work is concerned, of ordinary construction. The base over which the "basket-work," plainly seen in these photographs, is applied is a life-boat of the usual type. However, the exterior is covered with a heavy layer of firmly woven reed which serves to increase buoyancy and at the same time protect the boat itself from injury. When the boat is in need of painting, the paint is applied directly to the reed. The two long bulges contain cork to aid floatation.



LOWERING THE BOAT

AFTER the lever illustrated above has been pulled and the chocks have fallen away, turning of the hand wheel as shown at the left swings the boat out into position for easy lowering. The hand wheel is connected to a horizontal gear wheel on the forward davit by means of a worm. The davits are so spaced and connected at their heads by a steel bar that the boat is rigged right out into position for lowering without any trouble. In this photograph the bulges containing cork are plainly visible on both sides of the craft. It was said by Captain Haak of the Dutch *S. S. Callistro*, on which these boats are installed, that he has launched boats of this type heavily loaded, yet not a drop of water entered. Boats somewhat similar to these were used during the World War.



◄ THE RELEASING MECHANISM

WHEN the releasing lever, see upper photograph above, is operated, a sort of crankshaft is moved, causing the chocks that hold the boat in position to drop away and release the boat. This crankshaft and the chocks are plainly shown in the illustration at the left. At the same time the chains that hold the boat from swinging on the deck are loosened.

THE STEEL "TRACKS" ►

WHEN the boat is to be lowered from the high side of a vessel that is listing badly, it can slide down the side without catching on the laps or plates. This is made possible by the use of steel "tracks" or runners held on wooden blocks as shown. When the boat is in the water, these runners can be released so as not to impede motion of the boat in the water.

The Month In Medical Science

A Review and Commentary on Progress in the Medical and Surgical Field

Water Treatments in Disease

SINCE the time of Hippocrates, and perhaps long before that, water has been used in treating disease. Warm-water baths are sedative, cold presumably stimulating. Cold increases the elimination of carbon dioxide, whereas heat reduces it. Alternating hot and cold baths are invigorating. An indifferent bath with the temperature ranging from 94 to 95 degrees keeps the heat-regulating apparatus in equilibrium, and continuous baths of this temperature are regularly used in hospitals for the insane to quiet excited patients.

Carbonated or Nauheim baths started at a temperature of 92 degrees, Fahrenheit, are much used in treating patients with heart disease. They are believed to reduce the size of a dilated heart and to promote its contractile power. Such baths are available in Glen Springs and Saratoga Springs, New York, at Galen Hall in Atlantic City, and in the hospital of the University of Pennsylvania.

One of the most commonly used methods of treating painful joints or swollen limbs is the continuous whirlpool bath of a fixed temperature. The whirlpool bath originated in France and has been greatly improved by American inventive ingenuity. The temperatures range between 104 and 120 degrees; air under pressure is introduced below the surface of the water, which is given a swirling motion as water is mixed with air forced by the aerator. The duration of the bath varies from 40 to 45 minutes. It is much used in government hospitals when applying heat to stiff joints. The army authorities do not recommend it for inflamed joints or for conditions in which the nerves are involved. Other authorities recommend its use for fractures and sprains and for treating flat feet and chilblains.

The Number of Red Blood Cells in the Human Body

EVER since the red blood cells were first seen in the circulating blood more than 100 years ago, scientists have been endeavoring to determine such facts as the amount of blood flowing in the veins and in the arteries of the average person and the number of red blood cells. Indeed, accurate measurements of temperature, pulse rate, breathing rate and other measurable factors are of the greatest importance in measuring the extent or nature of disease. Obviously all of these determinations are subject to human error associated with the one who makes the observations and with defects of apparatus that is used for making of the important measurements.

A "WHIRLPOOL" LEG BATH

Air from a pressure tank is introduced below the surface of the water, causing a swirling motion

The number of red blood cells is important particularly in relationship to such diseases as pernicious and secondary anemias. When the number is considerably below 4,500,000 per cubic milimeter, the person is likely to breathe with difficulty and have little vitality or resistance to disease. In a figure as large as 5,000,000, a variation of 10,000 does not make a considerable difference. However, larger variations are of importance.

Recently Dr. C. D. Leake and his colleagues have taken samples of blood at hourly intervals from students 10 to 30 years of age. They find that the number of red blood cells may vary by 345,000 at various times during the day for men, and 310,000 for women. In the same way, the specific gravity of the blood varied by 0.0038 for men and 0.0027 for women, with general averages of 1.0565 and 1.0533. The determination of such variations is of the greatest importance in permitting a clinician to estimate changes in the patient's state and to interpret laboratory observations. A daily variation of as many as 315,000 cells is possible under normal conditions; variations of less than this amount need not be given great significance in relationship to disease.

Acidosis

A MODERN word with which to conjure in promoting all sorts of foods is acidosis, about which unfortunately there is much misunderstanding among the public as to the exact significance of the term. Obviously it means too much acid in the system, although as a matter of fact an acid reaction of the human body is incompatible with human life. The term, therefore, means that excessive amounts of acid substances other than carbonic acid are present in the body.

In the presence of acidosis, there is a decrease in the carbon dioxide and an increase in the hydrogen iron concentration of the blood. There is also a lessening of the carbon dioxide tension in the air that the person breathes out. It is possible to obtain evidence of the degree of acidosis by testing the excretions of the body, but these tests are not so reliable as those made on the blood. One of the simplest tests is to give a large amount of a substance like sodium bicarbonate, or baking soda, which is alkaline, and to find out how much is needed in order to cause the excretions to give an alkaline reaction.

In the presence of acidosis, which is associated with various symptoms of distress, it is customary to prescribe alkalis like bicarbonate of soda and also to recommend the eating of fruits which tend to alkalinize the system. Such acid or acidulous fruits as apricots, cherries, lemons, quinces, strawberries, raspberries, gooseberries, oranges, grapefruit, peaches, apples, pears, plums and grapes contain free acids, but their alkaline acids are burned up in the system, giving rise to carbonic acid and are excess of alkali.

The Possible Bacterial Cause of Trachoma

THE infectious condition of the eyes associated with granulation of the lids and sometimes with loss of eyesight has long been the subject of investigation by physicians. The terrific extent of this disease among the Indians has been one of the major problems attacked by the United States Government in the care of this people. So serious indeed has this condition become, that the Japanese investigator, Hideyo Noguchi, of the Rockefeller Institute for Medical Research, was asked by the Department of the Interior to undertake an investigation of its cause in New Mexico.

Attempts were made to transmit the disease to apes by inoculation of material and to isolate various bacteria from the tissues. In his studies, Dr. Noguchi secured a micro-organism which he was able to grow in pure culture and with which he was able to induce a grandular inflammation of the eyelids similar to trachoma. The organism was found in four out of five cases carefully studied, and this organism only, among all of those isolated, produced the lesions in the eye of the monkey.

The evidence submitted by Dr. Noguchi was sufficiently strong to cause competent specialists in diseases of the eye to say that the burden of disproof lay on other investigators. In other words, they were inclined to believe that he had actually discovered the germ capable of causing inflammation of the eye similar to trachoma in the American Indian. As has been shown for many other diseases, the determination of the causative organism is the first step in complete prevention and control.

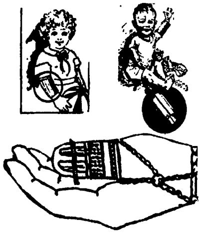
Thumb Suckers

THE Freudian or psychoanalyst of other schools is likely to insist that thumb sucking is associated with a secondary sexual disturbance of some sort and represents a desire of the child to return to its nursing period, perhaps an "unconscious desire." The mental hygienist objects to thumb sucking on the ground that it produces dream states in the child and delays its mental development. The dental hygienist asserts that it is a prolific source of malformation of the jaws and of the teeth and should be stopped for this reason, if for no other.

The specialists in diseases of children, in their attempts to overcome the habit, prescribe evil-tasting glues or other mixtures to be put upon the thumb to cultivate in the child a distaste for the process.

Many inventive geniuses have developed devices which make thumb sucking impossible, or at least so uncomfortable that the habit is abandoned. If the child is a girl, as she grows older and begins to appreciate the importance attached to nicely appearing fingers and finger nails, she is likely to abandon the habit for this reason only. Some people bring about a cure by systems of rewards and punishments.

The simplest device is a mailing tube of cardboard sufficiently large to put over the elbow as a cuff, which prevents bending the arms at the elbow, and thereby the possibility of putting the thumbs into the mouth. These can be homemade, but are also manufactured in various colors and with tapes for their attachment. Some persons apply adhesive tape in various configurations to the thumb and thus make its mastication undesirable to the infant.



ANTI THUMB-SUCKERS

Many mechanical devices have been made and patented with the point in view of stopping infants from sucking their thumbs. Three of these, the usages of which are obvious, are illustrated in the above drawing

The devices for thumb-sucking prevention are interminable and novel. Some of them are shown in the illustrations. If the child is old enough to understand and reason, an intelligent mother, and certainly an intelligent specialist in the care of children, will be able to wean the child early from the habit. For the younger infant, any one of the devices shown may prove successful.

Testing the Circulation

THE pulse rate has been used by physicians since the earliest times as a test of the nature of the circulation. More recently tests include determination of the rate while the person is lying down and while he is standing up. Attempts were made to find out whether the pulse responds promptly to exercise and the time is measured that is necessary for the pulse rate to return to normal after exercise. It is believed that a slow heart rate while lying down and standing up, with a small difference between the two, a slight acceleration of the heart rate in exercise with a quick return to normal afterward and a rise in the blood pressure on standing are excellent health signs. A person who responds correctly to these tests is then known to have a good blood circulatory system.

Recently, Dr. Abby H. Turner of the Harvard School of Public Health showed that even in healthy persons there is a fall in the circulatory minute volume on changing from a reclining position to a sitting or standing position. Apparently the circulation of the blood in the human being is not even yet perfectly adjusted to a standing position. Evolutionists recognize that many of the difficulties within the human system are due to the change from the four-footed to the erect posture.

In these studies it was found that the holding of a quiet standing position for several minutes is quite a difficult task for many people. Some persons whose blood circulation adapted itself readily to strenuous exercise found standing quietly a most difficult procedure. Persons who stand most easily and successfully are those in whom there is a slow heart beat and a relatively large pulse pressure. Persons who exercise without great stress on the circulation of the blood are also able to stand quietly for considerable periods of time without fatigue. In other words, the standing erect test is quite esily correlated with the other techniques for determining the quality of the circulation.

The Kahn Test and the Wassermann Test

IF any scientific diagnostic procedure is well established it is the Wassermann test for the detection of one of the most widely disseminated venereal diseases. So firmly has this procedure been established that almost any one can name the disease for which the test is used and its significance. It, therefore, becomes especially difficult to displace this procedure with any newer method, even admitting special qualifications for any such revised technique.

However, Dr. R. L. Kahn of the Michigan State Department of Health devised some years ago a precipitation test which has been gaining ground steadily in this country.

A recent report records the results in 300,000 cases of which more than 175,000 had been directly compared with Wassermann tests. These revealed the fact that the Kahn test is more sensitive than the Wassermann test both for the blood and for the spinal fluid. The advantages of the Kahn test are the use of cheaper material, and the lack of necessity for incubating the material over night. Thus the results of the tests may be determined within a period of a few minutes.

New Lights For Old

A Little Light on a Dark Subject

By H. AUSTIN TAYLOR
Assistant Professor of Chemistry, New York University

Silhouette of author photographed by light of phosphorescent background

THE cat and the owl have long been envied by man for their ability to see in the dark, or rather in what appears to man as dark. As a result, man has attempted to find means of aiding his normal vision. The most recent attempt in that direction appears in the form of small buttons, thumbtacks, or pendants which are capable of shining in the dark. The various luminous faces on watches and clocks are evidence, too, of this effort on man's part to assist his eyes during the darker periods of his existence.

This ability on the part of certain chemicals to give out light in an otherwise dark enclosure is classed by scientists under the general term of "phosphorescence." From all matter there is in some degree a response called forth when light shines upon it. The degree of response will depend on various factors—on the intensity of the light and its color, for example. The form of the response will differ, too, for different substances.

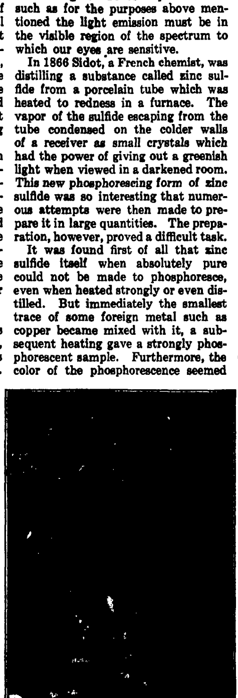
AS far as transmission of the light is concerned, glass is transparent, wood is opaque, while other materials show an intermediate transparency. Regarding these facts from the point of view of the material itself, the glass does not absorb the light at all, the wood shows complete absorption, while the intermediate substances show each a definite degree.

The question of interest in such a case is what happens to the light when it is absorbed. Light, we know, is merely one form which energy can take, just as is heat. A substance which absorbs light is therefore gaining energy, and when the light is removed it will tend to lose that energy and revert to its normal state. One form which this dissipation of energy may take is in an increased motion of the particles of which the matter is composed, an increased motion which evidences itself to our senses as heat. Another way that some bodies have of freeing themselves of the absorbed energy is simply to re-emit it. It is with this re-emission of absorbed energy that phosphorescence is concerned.

Phosphorescence may be a much more general phenomenon than we would at first realize. Not all light is visible to our eyes. There is beyond the visible region of the spectrum a far greater region of light to which our eyes are not sensitive, and consequently substances which emit their absorbed energy in that portion will not seem to be phosphorescing so long as we use our eyes as the measure of emitted light. To be of practical use such as for the purposes above mentioned the light emission must be in the visible region of the spectrum to which our eyes are sensitive.

In 1866 Sidot, a French chemist, was distilling a substance called zinc sulfide from a porcelain tube which was heated to redness in a furnace. The vapor of the sulfide escaping from the tube condensed on the colder walls of a receiver as small crystals which had the power of giving out a greenish light when viewed in a darkened room. This new phosphorescing form of zinc sulfide was so interesting that numerous attempts were then made to prepare it in large quantities. The preparation, however, proved a difficult task.

It was found first of all that zinc sulfide itself when absolutely pure could not be made to phosphoresce, even when heated strongly or even distilled. But immediately the smallest trace of some foreign metal such as copper became mixed with it, a subsequent heating gave a strongly phosphorescent sample. Furthermore, the color of the phosphorescence seemed to depend on this foreign metal.



PHOTOGRAPHS ITSELF

This picture, painted with multicolored phosphorescent paints, photographed itself

This was a most startling result, since it has later been shown that the intensity of the phosphorescence as well as the color depends on the amount of this "impurity" and is extremely sensitive to it. One part of copper in a million parts of zinc sulfide is more than sufficient to cause a faint phosphorescence. As the amount of copper is increased, the brightness of the phosphorescence increases until, with one part of copper in 5000 parts of zinc sulfide, the maximum intensity is reached. Further addition of copper then causes a decrease in the brightness of the emitted light.

When manganese replaces copper as the "impurity," the color of the light which is emitted in the dark is orange, and the maximum intensity of phosphorescence requires from 10 to 50 times as much manganese as copper. This partly explains the difficulty of the preparation of phosphorescent bodies such as zinc sulfide. To be sure that just the right amount of "impurity" is present is a difficult task.

A FURTHER difficulty is connected with the heat treatment of the sulfide, which also is necessary. Zinc sulfide can exist in at least two crystalline forms. Just as carbon can exist as diamond and as graphite, so zinc sulfide can exist in two different crystalline forms one of which is known as sphalerite—more commonly as zinc blende; the other is known as wurtzite; of these only the wurtzite is phosphorescent.

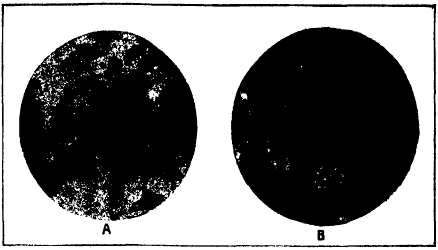
This was shown recently by means of a very pretty experiment by Guntz, like Sidot, also a French chemist. Some zinc blende, which always contains traces of copper, was heated for a short time to allow some of the blende crystals to change into the wurtzite form. This mixed sample was then examined under the microscope (See figure). When viewed with a light shining on the surface the crystals of wurtzite stood out black against the white background of blende, but when the light was shut off the reverse was true because the wurtzite phosphoresced while the blende did not.

That seems to prove conclusively that only the one form of zinc sulfide can emit its absorbed energy as visible light. Now, since the wurtzite form can be obtained only from zinc blende by heating almost to fusion we see the necessity of the heat treatment.

Many other substances than zinc sulfide also have this power of phos-

phorescing under certain conditions. Calcium sulfide, when exposed to light and then viewed in the dark, emits a distinct violet color. Barium and strontium sulfides too have each their own distinct phosphorescence which also depends on the "impurity" present. In these latter cases bismuth is the more generally added material.

Another very interesting fact concerned with phosphorescence is that its lifetime is quite definite under a fixed set of conditions. If we keep the luminous substance in a room at a fixed temperature and expose it to white light of fixed intensity for a few seconds and then shut off the light, the substance will glow quite brightly at first. But as time goes on the brightness decreases until eventually it is no longer visible—the phosphorescent light goes out. If we repeat the exposure to the exciting light under exactly the same conditions and for the same duration, the phosphorescent light remains visible for exactly the same length of time.



MICROPHOTOGRAPHS OF WURTZITE IN ZINC BLENDE

WE may alter this length of time during which the phosphorescence lasts by altering any of the conditions mentioned. For example if we raise the temperature, the phosphorescence does not last as long but seems to glow more brightly while it does last. Alternatively if we cool the substance we may make the phosphorescence last almost as long as we please, but again the brightness or intensity of the phosphorescence is decreased while it lasts. In fact, when we get down to the low temperatures attainable with liquid air the intensity of the phosphorescence is so weak that the substance is said to be no longer phosphorescent.

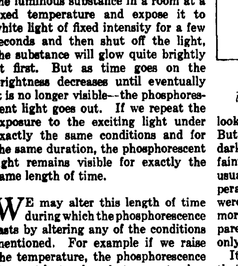


DIAGRAM OF APPARATUS

This apparatus, used to measure the rate of decay of phosphorescence, is described in the accompanying text

If we expose zinc sulfide at these temperatures to white light and then look at it in the dark, it remains dark. But if we now let it warm up still in the dark it will eventually begin to get faintly luminous and will glow with its usual green light so long as the temperature remains elevated. If we were to lower the temperature once more the phosphorescence would apparently cease and reappear again only as the substance warmed up.

It must be pointed out first, however, that light is not the only cause of phosphorescence, but that X rays, cathode rays and radium will also excite it in phosphorescent bodies. Coolidge, using his new cathode-ray tube, [See SCIENTIFIC AMERICAN, December, 1926,] excited some cadmium tungstate so that it phosphoresced in the dark, the color being slightly greenish. When the substance was cooled in liquid air no phosphorescence was observable even with simultaneous irradiation. On allowing it to warm up, the tungstate glowed first blue, then green, then yellow and later red, passing, that is, through the whole spectrum of colors. Furthermore if at any time during the warming process the tungstate was again thrust into liquid air the phosphorescence at once ceased, and on allowing it to warm up commenced to phosphoresce again only at the temperature and with the color that it had when the second cooling was made.

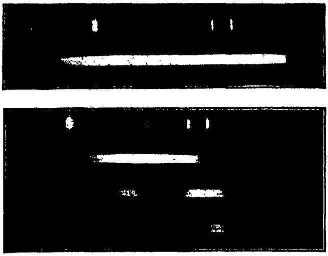
There seems, therefore, to be a definite temperature range within which a certain color is given off.

Such a difference between Coolidge's experiment and the one previously cited for zinc sulfide is due, no doubt, in part to the use of a different agency than light for producing phosphorescence. As mentioned above, beside light and the cathode rays which Coolidge used we may also use X rays or radium as the exciting source. With X rays the phosphorescent effects are precisely the same as with light, except that they are more intense, as would be expected from the consideration that X rays and visible light are but two of the forms which light can take. In the case of the cathode rays, which are a stream of electrons traveling with a high velocity, the energy of the impact of the electron with the phosphorescent material is probably the equivalent of the energy which the material would absorb from light.

All of these methods of excitation of phosphorescence however require frequent exposure of the material if continued phosphorescent light is desired. It is for that reason that radium paints are now in frequent use for all practical purposes. In such paints the phosphorescent material such as the zinc sulfide is mixed with a minute quantity of a radium salt or other radioactive substance. The radioactive decay which this compound undergoes continuously causes effects which are similar to the effects of light, X rays or cathode rays, but being constantly present the phosphorescence is continuously caused; the substance glows constantly and does not appear to decay as in the cases above cited.

FOR practical purposes as a source of light in a dark room therefore the radium paint is a "never-failing" source—that is, until the minute trace of radio active substance has completely disintegrated, a process taking many years. However, the simple phosphorescent material excited for a given length of time by an external agency furnishes more definite results for theoretical purposes.

Some new investigations recently carried out in the physico-chemical laboratories of New York University have revealed to the writer another way in which one can cause the more rapid decay of the phosphorescent



SPECTROGRAMS

...of the spec- ... by phos- ...inc sulfide. The upper spectrum in each case is that of the mercury arc, for comparison. The first band (upper picture) is due to green phosphorescence. The three bands in the lower picture are of green, yellow and orange samples, respectively. The lower two show two bands each, one in blue-green and one in the orange region

light. The method consists in exposing the substance while it phosphoresces to light of a different color.

A simple, diagrammatic sketch of the apparatus employed is shown in one of the accompanying illustrations. A sample of the material is mounted on a plate, A, maintained at constant temperature in the oven B. Radiation from source C activates it after passage through a photometer E, wherein, by means of a small right-angled prism H, light of constant intensity and color from the source F and filter G, can be viewed at the same time for comparison.

As an example of the accelerated decay brought about, the zinc sulfide, containing copper, which normally glows with a greenish light in the dark, can be made to lose its phosphorescence more rapidly than it would lose it in the dark, by exposure to red light. This can be made evident by exposing a layer of the substance to some exciting light, then covering half of the layer and exposing the other half to a red light for a few moments. On viewing the whole layer in the dark it will be seen that the portion exposed to the red light does not glow as brightly as the portion which was covered; it has, in other words, decayed more rapidly.

THAT fact may be coupled with the action of various kinds of light in causing phosphorescence. The color of radiant energy or light is simply a matter of its wavelength, just as the reception from a specific radio-broadcasting station is a matter of wavelength also. Now, a law of phosphorescence found by Stokes states that the wavelength of the phosporescent light is always longer than the wavelength of the exciting light, so that for zinc sulfide, which phosphoresces green, the light to be used as exciting light must be of shorter wavelength than the green light.

Any light of wavelength shorter than the green, provided it is absorbed by the sulfide, will cause it to glow. Any light of wavelength longer than the green will not cause it to glow, but, if the substance is glowing already, will cause that glow to decay more rapidly than it normally would.

To demonstrate that more completely, suppose we take a sample of zinc sulfide which phosphoresces in the green portion of the spectrum and one containing some cadmium sulfide which will phosphoresce with a red light. If we expose both of them to blue light they will both phosphoresce in the dark. If we expose both to yellow light, only the red sample will afterwards glow in the dark, while if the green sample be made to phosphoresce and then exposed to the yellow light it will decay more rapidly. Finally, if both are already glowing and we expose them both to a very deep red light both will decay more rapidly than they would normally.

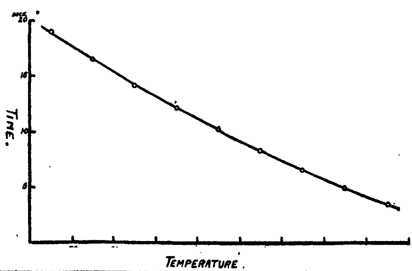
The explanation of these effects which are quite general with regard to the phenomena of phosphorescence, is being urgently sought by both physicists and chemists, in the hope that it may furnish some further insight into the structure of matter—the atomic make-up. How is the energy held by the atom when light is absorbed? Is an electron displaced within the atom, to return later with a re-emission of light as phosphorescence? Why must the "impurity" be present for phosphorescence? Why does only one of the crystalline forms phosphoresce and not the other?

AND while all these questions are worrying the theoretically minded, the practical minds are thinking out new applications of the results found for the use of mankind in general. Already we may read the time in the dark and find our way without stumbling, guided by means of luminous buttons placed at salient points in our homes. Already, too, we are amused at the vaudeville shows and the "Follies" by the weird effects produced by the phosphorescence on the dresses of dancers pirouetting in the dark before an ultra-violet light—a light which, although not visible to our eyes, is capable of causing the phosphorescence since it is of shorter wavelength than the phosphorescent light itself.

What limitless possibilities still exist in the application of simple experimental observations to practical use?

One wonders whether the time is approaching when all our artificial lighting will come through the medium of phosphorescence. The possibility, even at this early stage, of storing in a phosphorescent substance sufficient energy from the sun during the daytime, to furnish light during the night, seems reasonably plausible.

May not such luminescence produced by chemical means be imitated on a large scale and adapted to practical use? Before such is accomplished, however, we must know more about the general properties of phosphorescence, the different ways of producing it, and finally, how to maintain it under useful control.



EFFECT OF TEMPERATURE ON RATE OF DECAY OF PHOSPHORESCENCE

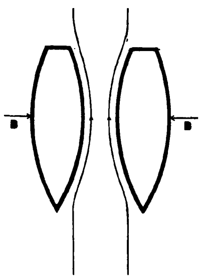
Increase in temperature hastens the decay and therefore decreases the time taken for the phosphorescence to decay to a fixed intensity, that is, it disappears more quickly when heated

On the Trail of the Molecule—II

What Makes Some Chimneys "Draw" Poorly, Boomerangs Soar, Rotor Ships Move and Golf Balls Curve? "Bernoulli's Principle" Explains It

By PROF. S. R. WILLIAMS
Fayerweather Laboratory of Physics, Amherst College

IN last month's installment of this article we saw how two balls were drawn toward one another in a seemingly paradoxical manner when a jet of air or water was directed against their juxtaposed surfaces. Two boats anchored in a stream as near to each other as the width of one of



All illustrations by the author

WHY BOATS DRAW TOGETHER

FIGURE 11: *This phenomenon is easily explained by Bernoulli's theorem*

the boats will be drawn toward each other for the same reason.

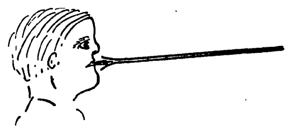
Figure 11 shows the sweep of the lines of flow of the water past the boats, making the pressure less at A than at B and B. Dynamically it will be the same whether the boats are moored in a stream or are moving forward side by side, for in either case the space between the boats is at reduced pressure. In naval maneuvers it is not an unknown accident for the navigating officers to neglect to take such forces into account, whereupon the boats collide.

Figure 12 illustrates another way in which the forces operative in a fluid stream which flows between two obstacles may be demonstrated. The parallel edges of two sheets of paper are held about three-fourths of an inch apart, and when one blows between them they pull together very tightly.

The author had a personal experience of this kind of force some years ago which may help to explain to others why hot-air furnaces at times do not work satisfactorily. His house stood on the west side of the street about 30 feet from another house. The winds in

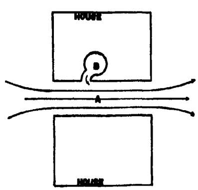
BLOWING PAPERS

FIGURE 12: *An attempt to separate two papers by blowing between them (cigarette papers, for example) often results in drawing them together and stubbornly holding them there —Bernoulli's theorem again*



that region prevailed from the southwest to such an extent that the trees had a slant toward the northeast. These westerly winds swept down between the houses, (Figure 13), as did the water between the boats in Figure 11, and the tendency was for the houses to pull together as did the boats, or like the sheets of paper in Figure 12.

As the houses were well anchored they did not move. But something else did. It happened that the cold-air inlet to the furnace was on the side of the house next to the neighbor's. After strenuous efforts in stoking the furnace during an unusually cold season, it became apparent one morning, on placing the hand over the register, that one could feel the air going *down* the register rather than *up*, as it should. This observation was confirmed by going out to the cold air inlet and noting that a bunch of sparrows flew out of it where they had been warming their toes in what had become a "warm air outlet."



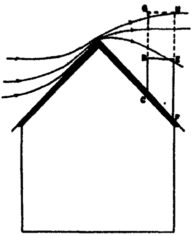
A FURNACE "ON STRIKE"

FIGURE 13: *A hot-air furnace "heated backwards." What was to blame?*

The space, A, between the houses, being a region of constriction, the pressure there was less than in the furnace, B, and so the hot air was aspirated out, causing the furnace to work backward. The trouble was remedied by putting the cold air inlet on the west side of the house. Since hydrodynamic pressure is less than hydrostatic pressure, the pressure outside of a house when the wind is blowing is less than that inside, and the result is that our houses have the warm air sucked out of them when the wind blows in the winter, rather than blown out as is the popular conception.

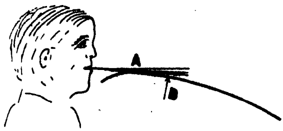
THE draft to a chimney is tremendously influenced by these constrictions to flow of which we have been speaking. If the wind blows directly across the top of a chimney, it acts like an aspirator and the draft is improved. Or better still, if the wind can be given an upward cut past the top of the chimney, one has a forced draft. Any downward slant to a breeze past the top of the chimney militates against a good draft.

A couple of feet added to the height of a house chimney will make a very great difference in the way it draws, and this cannot be ascribed entirely to a greater length of warm air column balanced against the cold outside, which is supposed to make tall chimneys for mills draw well. Figure 14 illustrates the point under discussion. Sometimes the architect has in mind beauty rather than utility and will keep the chimney low, as in CDEF. If the wind is blowing over the comb of the roof, the stream-lines will be somewhat as shown, and those streamlines which strike at a level with DE



WHY SOME CHIMNEYS SMOKE

FIGURE 14: *Elevating the top to GH often solves the difficulty. Why?*



AIRFOIL

FIGURE 15: *Blowing down on a sheet of paper in this manner will actually raise it. The peculiar curve which it assumes is not a mere coincidence with the curve of an airplane's wing—but this is a consideration in itself and so it must be left to the reader*

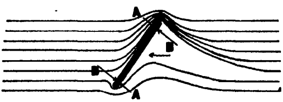
will be directed downward and the "chimney will not draw for a certain direction of wind." If the chimney is built to the height indicated by the dotted lines DGHE, then the stream-lines will be upward at GH and the chimney will draw satisfactorily no matter what the direction of the wind.

The top of a chimney in a wind is like the vertical tube in an aspirator which has points of constriction about it. Thus the smoke in the chimney, like the liquid in the bottle of an atomizer, is lifted to the top and is blown away.

If a single sheet of paper is held in the hands and allowed to fall down in a curve, as shown in Figure 15, one's first impression would be that blowing across the top of the sheet would blow the outer edge still farther downward. Such is not the case, but it is lifted instead. The shape to which the curvature of the sheet of paper is drawn in Figure 15 resembles that of the camber of the wing of an airplane. If a plane curved as in Figure 15 is forced ahead in stagnant air, the same conditions will exist as for the sheet of paper, and the space above the plane, A, becomes a space of constricted flow and therefore of pressure reduced below that beneath the plane. This unbalanced force provides one of the important factors in the lifting power of the plane. Likewise with the propeller blades on airplanes and boats—to be most efficient they must be constructed along similar lines if they are to give the greatest possible thrust.

Those who, in rowing a boat, try to feather their oars on the return stroke know that for the novice one of the provoking tendencies of an oar is to catch at one edge of the blade and instead of skimming the surface smoothly, dip down and go broadside into the water in a most undignified manner. If a large piece of cardboard is allowed to fall for some distance it will have a tendency to fall with its plane in a horizontal position. Bernoulli offers an explanation for these cases also.

In Figure 16 are shown the stream-lines about the blade of an oar as it is swept through the water or as the water flows past it. The sides of the edges marked A are points of constricted flow, in contradistinction to the sides of the edges marked B. Since the pressure at A is less than at B, the tendency for the blade as it moves through the water in the direction of the arrow is to turn at right angles to the direction of motion. Meteoric particles, which are lozenge-shaped, indicate by the fact that one side is fused more than the other that, as they move through the air, they also take on this tendency to move broadside. Doubtless there is some wabbling, as one also observes it in the case of the oar, as was just explained.



STREAM-LINES

FIGURE 16: *The stream-lines about a plane are symmetrical only when it is "edge-on," or when broadside. The tendency is toward the latter*

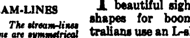
Some years ago a friend, forgetting to remove his glasses, dived off into deep water and came up minus his optical addenda. The first impulse was to dive in search of them. A little thought, however, led to the idea that the glasses, when they came off, would continue their journey to the bottom of the lake and move with the surfaces of the lenses broadside to the direction of fall and with the bows trailing in a vertical position, eventually resting on the bottom in that position. If they did this, it ought, in the clear water, to be possible to get the reflection of the afternoon sun from the surfaces of the glasses, and thus locate them. This was done and the glasses were speedily recovered.

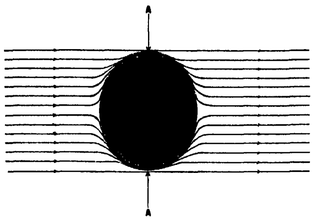
THE flight of a boomerang is a beautiful sight. There are many shapes for boomerangs. The Australians use an L-shaped stick. Others are made in the form of a triangle, a cross or a "T". They may be made with as many cross-arms as one desires. All of them, however, must have the cross-section of the blades a particular shape, similar to that in (*a*), Figure 17, which is really the cross-section of the wing of an airplane.

Suppose a boomerang has the form of a cross as in (*b*), Figure 17. When it is thrown, it is given a rotation about an axis at right angles to the blades of the boomerang. For illustration, let the plane of the boomerang blades be vertical and the top blade moving in the same direction as that of flight. Like a spinning top or gyrostat, it seeks to maintain its axis of spin in a

BOOMERANG

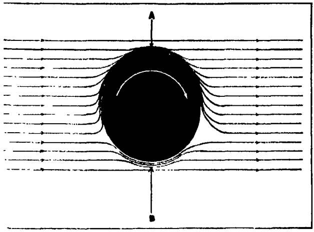
FIGURE 17: *The boomerang has a cross-section like that of an airplane's wing. Not all boomerangs are of the return type, while the statement often heard, that a boomerang can be thrown so that it will strike a man behind a tree and return to the thrower, is fabulous*





STREAM LINES AROUND A BALANCED CYLINDER

FIGURE 18: *As the cylinder is moved sidewise through the atmosphere, the stream lines of air around it are symmetrically distributed*



THE ROTOR OF THE FLETTNER ROTOR SHIP

FIGURE 19: *When the cylinder is rotated the stream lines are redistributed. Bernoulli's theorem explains why the ship moves*

fixed direction. As the boomerang spins, the blades will cut the air, so that the top blade cuts the air the fastest of all. Each blade, as it moves through the air, has points of constriction to movement of the molecules of air past the curved side. This causes an unbalanced force to push against the flat side of the blade. The top blade, as mentioned above, will have the largest unbalanced force acting upon it, and so the boomerang in Figure 17 will have its top tipped toward the left of the reader.

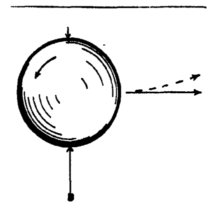
This unequal pressure on the different blades causes the axis of the spinning boomerang to change its direction, and so the boomerang as a whole begins to turn about the axis at right angles both to the axis of spin and to the axis about which the axis of spin is revolving; that is, it precesses and thereby makes possible the throwing of an object in such a manner that it will return to the thrower.

In his book, "Artificial and Natural Flight," page 39, Sir Hiram Maxim calls attention to a propeller with cross-section of blades shaped as in (*a*), Figure 17. "No matter which way it was run," he states, "the thrust was always in the direction of the convex side, which was quite the reverse from what one would naturally suppose." With the principle of Bernoulli in mind, the pulling effect of such a propeller is the only thing to expect.

IN these days a great deal is heard concerning the rotor ship. This type of ship is equipped with large cylindrical masts which rotate. When the wind blows past a non-rotating mast, as in Figure 18, the stream-lines or paths of the molecules will spread uniformly on both sides and lead on past them. On both sides, A and A, there are points of constriction. But being equal, the forces are balanced. If however, the mast rotates, the distribution of the lines of flow are not symmetrical and more molecules will be carried around one side than the other (Figure 19). The side on which this occurs is the equivalent of a constriction to flow and is therefore a side of reduced pressure. The greater pressure on the side of least constriction will urge the mast forward in a direction at right angles to that in which the wind is blowing. Hence, to sail most effectively with the rotor ship, one must have the keel of the boat at right angles to the direction of the wind.

A ball spinning in its flight, whether it be a baseball, golfball or tennisball will have the stream-lines about it as shown in Figure 19 and similar forces will urge it from its straight path. Whether a curve is an "out," an "in" or a "drop" will depend upon what direction is given to the rotation of the ball as it is sent on its flight. Figure 20 gives the direction of rotation and of translation for an "up" curve. As the air is carried around with the rotation of the ball toward A, the equivalent to a constriction is formed, which makes the pressure at A less than at B, with the consequent urge upward of the ball.

Those who have played golf have often observed the ball make a very graceful upward flight as it sailed down the fairway, and then very suddenly break with a drop. A noted English physicist is authority for the statement that if a golf ball is made very rough, and the iron for driving is also roughened so that a very violent rotation may be given to the ball on an undercut, that the point of breaking just mentioned may actually be made into a loop. Some very beautiful curves are often noticed when fouls are struck in baseball. Receiving the impact of the bat with a glancing blow, the ball is given a very lively spin. This is also essential to the curved flight of a pitched baseball.



THROWING AN "UP" CURVE

FIGURE 20: *Bernoulli's principle tells why a baseball curves, but the possession of this knowledge will not make one a famous pitcher*

ONE who is not an expert in pitching curved balls may obtain excellent curves by throwing ping-pong balls by means of a small trough fashioned with a handle like a bat. The ball is laid in the trough and then thrown with a rolling motion along the trough. In making sure of the rotation it will aid to dip the ball in thin shellac and roll it in sawdust. When dry this makes a rough surface and by pasting strips of sandpaper in the trough there will be no difficulty in making the ball spin. The relation between the speed of rotation and the speed of translation determines the amount of curvature of the path of the ball. Gall-balls from the oak tree make splendid balls with which to play in throwing curves. They may be thrown either by means of the trough or snapped by one's fingers.

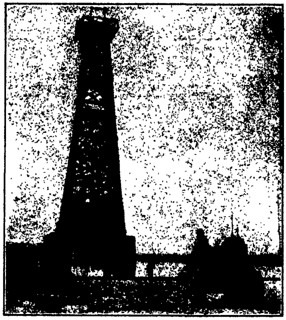
Whether it is a natural instinct or a modern heritage from Greek thought, the fact remains that man is continually seeking to arrange the facts of his universe in a rationally intelligible and unified system. History indicates that when man is most actively engaged in this pursuit, science and civilization make their most rapid advance. When we are able to bring together a great many diverse observations and show that there is a common cause back of them all, we speak of this cause as an underlying principle. Among the various experiments which have just been described it must be obvious that the Principle of Bernoulli is fundamental.

From the Scrap-book of Science-

P and A

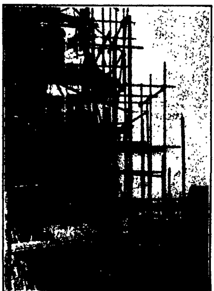
SMOKE SCREEN LAID BY WAR PLANE

To screen the movement of troops, artillery and other war materiél, airplanes draw smoke curtains around them. The enemy knows something is about to take place behind the screen but he does not know what, nor where to fire through the screen. Chemicals that furnish smoke are dropped from the flying plane



PORTABLE OIL-WELL DERRICK

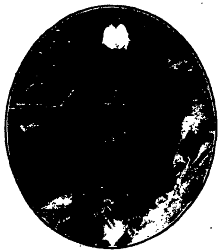
In Montana they make one derrick serve for drilling two or more wells, drawing it to the new site by means of a tractor. The derrick illustrated above weighs 36 tons and is 82 feet in height



International Newsreel

PIPE SCAFFOLDING

After the wooden scaffolding on a New York skyscraper construction job burned, a scaffolding composed of sections of two-inch pipe was tried. It is said to have made good



TUNNELING MACHINE

This new machine is equipped with pneumatic tools for tunneling without explosives. There are 18 pneumatic chisels which make a clean cut as the machine slowly advances into the rock that is being drilled

P and A

"LEVIATHAN'S" PROPELLER

A new three-bladed propeller has just been cast for the steamship *Leviathan*. It weighs 64,000 pounds and is made of manganese bronze. Note the comparison with the man

◄

NEW NEON AVIATION BEACON

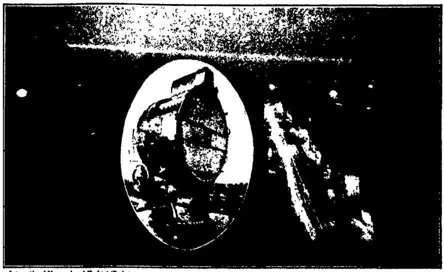
At Hadley Airport, New Jersey, a new aviation beacon consisting of four high-intensity neon lamps mounted at the top of a 115-foot steel tower has been installed for experimental tests. The light from the neon tubes is mostly red and it was reasoned the long waves of red light should penetrate fogs. Results are reported to be good. At sunset the sun is red because red light penetrates the longer atmospheric path

Camera Shots of Scientific Events

International Newsreel

NEW CABLE AIRWAY

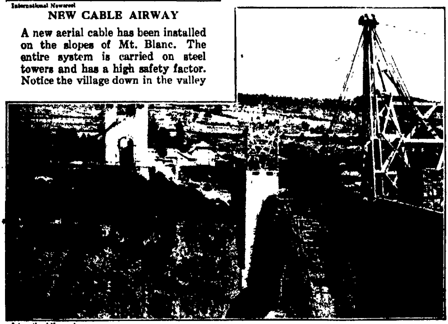
A new aerial cable has been installed on the slopes of Mt. Blanc. The entire system is carried on steel towers and has a high safety factor. Notice the village down in the valley



International Newsreel and Herbert Photos

WORLD'S LARGEST SEARCHLIGHT IN WEST VIRGINIA

At Charlottesville, West Virginia, a searchlight (insert) whose powerful beam is visible over 200 miles in clear weather has been installed for the purpose of illuminating from a distance of three miles the historic residence of Thomas Jefferson—"Monticello." In the picture the beam is shown playing on the residence



International Newsreel

NEW FRENCH ARCH BRIDGE MADE OF CEMENT

Since the World War, French engineers have developed to a high degree the technique of building arch bridges of concrete. The one shown in the illustration above has a span of approximately 800 feet and is 450 feet in height

SUBTERRANEAN SUBMARINE!

After long search at Paterson, New Jersey, students of Stevens' Institute of Technology uncovered from the mud the first submarine that was built by John P. Holland

THE "JOHN B. JERVIS"

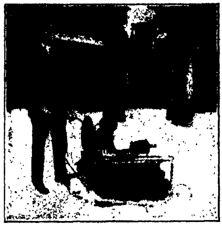
This is the second of the new combination firetube-watertube boilered locomotives put in use on the Delaware and Hudson Railroad. As the addition of new features gave the locomotive a rather cluttered-up appearance, this one has been sheathed far outside the boiler. The unusual steam pressure used is 400 pounds per square inch. The engine, with the tender, weighs 314 tons

Inventions New and Interesting

Examples of Inventors' Work Throughout the World

INSIDE-MEASUREMENT RULE

A very handy device for the use of carpenters and others requiring the services of this particular type of tool, is the inside-measurement rule illustrated above and at the left. Inserted in a groove in one end of an otherwise ordinary folding rule is a length of calibrated brass strip. This is marked accurately in inches and small fractions.

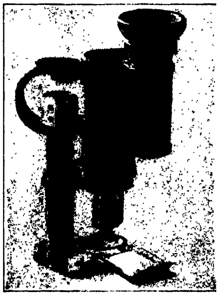


SNOW SWEEPER

Using the parts from a baby carriage, an old bicycle, a broken lawn mower, an old brush, and a decrepit two cylinder gasoline engine, an inventor has constructed the above illustrated sweeper.

STUDYING CORAL

From a well-known German firm of optical goods manufacturers comes the illustrated combination telescope and microscope. Above it is shown held in a stand so that the beauties of a piece of coral may be studied carefully. Other uses for it are illustrated on the right.



AS A MICROSCOPE

The combination instrument is shown clamped in position for use as a microscope. Accurate adjustments are possible

HELD IN THE HAND

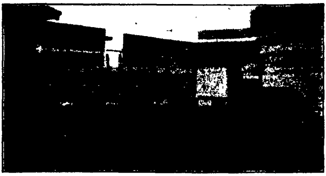
Here is illustrated another use for the versatile combination microscope and telescope which is illustrated at left.

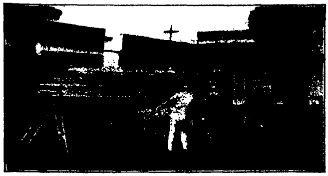
WINDOW WASHING MADE EASY

To facilitate the washing of railroad train and factory windows, the above apparatus has been devised. Any cleaning solution can be placed in the tank and fed along the flexible pipe line to the nozzle. At this point is a revolving brush which aids greatly the cleaning operation.

CLEANING CAR TRUCKS QUICKLY

This new high-pressure cleaning system has been installed in the shops of a San Francisco railway company. The method makes use of water at a pressure of 300 pounds per square inch. To speed up the work, the water is heated to 140 degrees and then forced through a flexible hose.





QUICK LOADING OF LUMBER TRUCKS

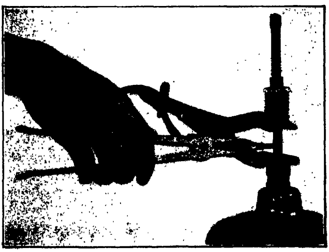
Loading stands which permit lumber to be piled, ready for placement on the truck, are the latest time-saving devices in the lumber industry. In use, the stands are placed and loaded with planks. The truck backs up, the front loader is removed, and the truck is backed further. The load of lumber then slides into place over rollers on the truck

PORTABLE PYROMETER

With the small instrument illustrated at the left, it is possible to determine the temperature of a furnace or other fire, while the operator of the device remains at a comfortable distance from the flames ◄

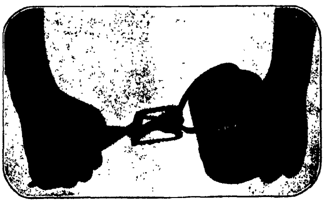
MICROSCOPE LIGHT

The horseshoe shaped object shown at the right is a newly developed electric light for use in illuminating microscope slides. It is said to eliminate casting of shadows which tend to confuse the microscopist



VALVE TOOL ▲

Those who have worked with machinery in which valves must be removed periodically for grinding will appreciate the little tool illustrated above. It is a device for the removal and replacement of valve pins or other valve-locking parts. By its use, the danger of the valve spring injuring the fingers in case of slippage is eliminated. One end of the tool is shaped to accommodate flat or round pin locks, and they can be held at any angle because of grooves provided. The other end, specially shaped for the purpose, holds yoke or horseshoe locks



PISTON RING TOOL

The device illustrated above is for the removing or placing of piston rings. By its use, the ring, of any standard diameter, can be gripped firmly and expanded so that it can be slipped into place on the piston without damage

▲ PISTON CLEANER

When placing new piston rings in an internal combustion engine, it is necessary that all traces of carbon be removed from the ring grooves. If this is not done, the new ring will not seat properly. The tool illustrated above is designed to facilitate the cleaning of the piston-ring grooves, and to do a clean job. There are four cutters for different widths of grooves, and they are instantly interchangeable. It is only necessary to loosen a nut and rotate the cutters to accomplish this change. The tool will handle pistons up to five inches in diameter

Culinary Inventions

Novelties for Preparing and Serving Foods

CONDUCTED BY ALBERT A. HOPKINS

BAKED "HOT DOGS" ▲

A new form of electric baker for turning out a new type of baked product is illustrated above. A frankfurter, sausage, roll of hot meat, or similar delicacy is placed in the center of a roll of dough, the whole is placed in the baker, and four minutes later, a delicious baked sandwich results. It is interesting to note that no grease is employed in the process of cooking.

KEEPING FOOD WARM

Where large numbers of persons are to be fed, the problem of keeping the cooked food warm until the time of consumption is a difficult one to solve. However, by a clever combination of electrical heating units and insulated compartments, one manufacturer has succeeded in producing a device that serves the purpose admirably. One of the portable types is shown below.▼

IMPROVED DRINKING CUP

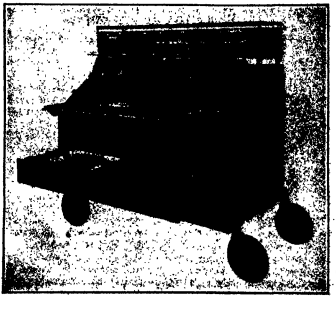
When drinking on a moving train or boat, or when in bed, there is always danger of spilling. This has been overcome by the unique cup illustrated in use above. The peculiar shape of the spout makes it impossible to spill the contents. It originated in France.

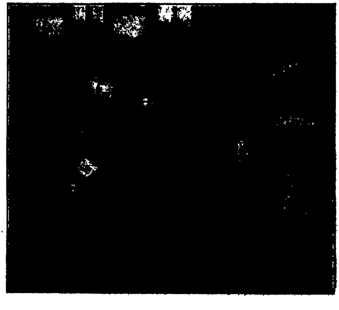
▲ DISHES KEPT HOT

Food dishes that keep hot and butter dishes that stay cool are now possible with the new design of utensil illustrated above. The dishes are made with a compartment in the base. If the food is to be kept hot, the compartment is filled with hot water through the filler hole provided. For butter dishes and the like, ice water is used. A screw plug closes the filler hole.

ANOTHER FOOD WARMER

In the illustration directly below is shown another device for keeping cooked food at the proper temperature for consumption. It is similar in construction to the one depicted at the left, but is stationary, while the other one is mounted on small wheels so that it can be moved to any desired spot, thus being particularly suited to hospital use where many patients are to be served.





The Scientific American Digest

A Review of the Newest Developments in Science, Industry and Engineering

CONDUCTED BY ALBERT G. INGALLS

Truck Unloads Itself

TO save the time of trucks which lie idle while warehouse-men are loading them has been a problem over which efficiency experts have puzzled for years, and many schemes have been devised to speed up the loading operation. Austin Denehie, a young Los Angeles inventor, has perfected a device which is said to be the answer to the problem.

Denehie has constructed a frame of steel which is bolted to the chassis frame of a truck, with a jackscrew shaft down the center. The jackscrew shaft is compound threaded and is driven by a standard power take-off which can be engaged by throwing a lever in the cab. As the shaft revolves it carries a demountable body on or off, according to whether the lever is thrown forward or into reverse.

Slung under the demountable body are swivel castors which permit the body to be pushed around the loading platform by hand, or if need be, taken into the warehouse itself.

It takes only eight seconds for the empty body or a loaded one to be moved from truck to dock, or vice versa, while the stopping, coupling and locking devices are all automatic so that when the machinery is put in motion the driver need pay no further attention to it.

Starting the body loader to work. The lever which is being manipulated will be inside the cab in commercial units. It was placed in its present position on the working model so it could be more easily seen in action

Floating Factories

SOMEWHAT tardily, according to Lewis Radcliffe, Deputy Commissioner of Fisheries, writing for *Science Service*, the fisherman is seeking the aid of science—engineering, technology and chemistry. Thus he is developing ways of greatly expanding his sphere of operations. This effort to make available more distant sources of supply is most commendable.

The automatic body loader in detail. The sub-frame is bolted out [illegible] are shown on the [illegible] clamp which holds it in place. The threaded shaft shows in the center of the body

The better insulation of the holds of the fishing vessels and the development of refrigeration machines suitable for installation and operation on board his vessels have greatly increased the distance he may go from his home port. California fishermen are enabled to take much greater toll of the fish supply off the coasts of Lower California; salmon are brought to this country from Kamchatka; the French have built a vessel for operation off the African coast, and other European countries with a diminishing supply in the North Sea and around Iceland are now drawing upon the fishery resources of Greenland. The day is at hand when the fishermen may supply our table with aquatic delicacies from the remote corners of the earth.

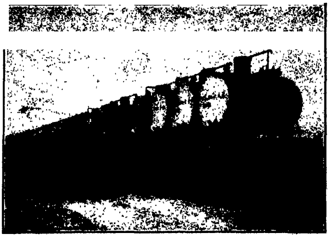
Norwegians have perfected whaling ships capable of operating in the Antarctic, thousands of miles from their home port. These ships are fitted with a false bow which can be tilted downward into the water to serve as a runway, up which one of these huge mammals may be drawn to be cut up. Machinery aboard extracts the oil from the blubber and converts the carcass into fish meal. These ships are independent of a land base and having filled their storage tanks with whale oil, which is in special demand by soap-makers, may steam to whatever world port holds forth the best promise of a profitable market for their cargo. In recent years the number of whaling companies has increased rapidly and no ocean area is exempt from whaling operations. In excess of 10,000 whales are killed annually, the maximum yield of oil being reached in 1923, amounting to 44,000,000 gallons. Millions of gallons of whale oil now find a ready market in this country.

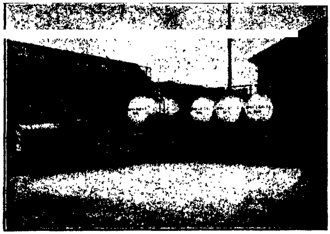
This freedom of operations without restraint on the high seas has aroused the fear of intelligent observers that whales may soon become commercially extinct. The only possible control of such operations must be found in international agreement. Such a solution is now being sought by no less an august body than the League of Nations.

A recent development on our own coasts has added emphasis to the dangers resulting from unrestrained operations on the high seas. California authorities have constantly striven to restrict the amount of sardines—so abundant off their coast—which shall be used by the reduction plants for conversion into oil and meal. This has been done so that the great sardine-canning industry may have an ample supply to satisfy the demand for this food delicacy. This "war baby" promises to become a permanent state industry, and is now producing more than a million cases of canned sardines per annum.

A short time ago a Nevada corporation anchored a fully equipped floating reduction plant within the limits of Monterey Bay, but three miles off shore, and proceeded to take sardines for reduction purposes outside the three-mile limit. The State Fish and Game Commission promptly took action and filed suit for a permanent injunction to restrain the company from continuing operations and this has been granted.

The menace still remains and unless some form of international co-operation





They can be transferred to motor-drawn

is evolved, we may have another "rum row" off our coasts, busily engaged in mopping up the fish supply with utter disregard of the needs for conservation, and bootlegging the manufactured products into whatever port where they can find safe entry.

The most novel development in floating fish factories is that of the *Calgary*, a French vessel of over 2600 tons. This vessel is being provided with powerful refrigeration equipment and three large cold-storage compartments with a capacity of 800 tons of fish. There are six retorts on board. One will be used for cooking lobsters and crayfish; another for making gelatin; two, capable of handling 40 tons of fish and fish waste per 24 hours for conversion into oil and fertilizer; and two others with a capacity of five tons each for the steam extraction of oil from the livers of sharks and rays. There are two oil storage tanks, one of 26,000 gallon capacity for storing fish oil and one of nearly 400 gallons for liver oil. Although it is proposed to operate the vessel off the west coast of Africa, it has been suggested that the vessel may visit Iceland, Greenland, and even North Atlantic fishing banks adjacent to our own coasts.

The power of science in making far distant resources available is well illustrated by these developments. Unless subjected to proper international control, these same developments may encompass the ruination of important aquatic resources and leave us poorer than before.

Submersible Fl
Used in

USING a new type of floodlight projector after other methods of searching had failed, it was possible recently to recover the body of a man from Province Lake, Effingham, New Hampshire. The man and his wife were drowned when their boat capsized. Despite the efforts of several volunteer searchers working with grappling hooks and dynamite, no trace of the man's body could be found, although the body of the woman was located promptly.

Two days later the submersible floodlight projector developed by the General Electric Company was relamped at Lynn, Massachusetts, to use a 250-watt, 36-volt incandescent lamp instead of the usual 110-volt one. Current was then supplied by three 12-volt storage batteries in series, carried in the boat of the searching party.

The floodlight projector, attached to a long pipe, was lowered to the bottom of the lake and the body was soon located in 15 feet of water, some distance from where the boat had capsized. It was so wedged between rocks that grappling hooks could not dislodge it. The divers who brought the body to the surface reported that, within the beam from the projector, it was easy to see objects on the bottom of the lake.

Novel Oil Transport Used In Germany

THE transport of oil in bulk by railway has always presented difficulties, mainly because the large tank-containers employed are fixed to a car frame or to the tops of the trucks. This usually means that the oil has to be discharged into other and smaller containers before it can be used, with a consequent delay or the installation of large containers which can be used for only a portion of the time. It is, therefore, not surprising that by far the greater part of oil traffic, especially for comparatively short distances, is sent by road in preference to rail, for the former method offers facilities for the transportation direct to the spot where the oil is needed, without the necessity of transferring it into fresh containers.

In Germany, however, where road transport has not developed so greatly as in other countries, most traffic is forced to go by rail. Hardly any new roads have been built in that country during the last thirty years, for during the period from the introduction of railways up to the outbreak of the war the transportation of freight and passengers was almost exclusively handled by the railways. The highways are used only for local transportation.

A firm of oil merchants in Berlin, who do considerable business all over Germany, have therefore adopted a system which permits them to send their traffic by railway as far as possible and to transport it from the rail terminal by motor truck without having to change the container in which the oil was borne by railway. This has been made possible by the use of small tank containers, each of which is mounted on its own wheels. Each con-

Lighted by ordinary storage batteries from motor cars, this special type of water-proof under-water floodlight aids recovery of sunken objects

tainer has a capacity of approximately 1100 gallons and a laden weight of about four tons. Special equipment is required to accommodate these containers, four of which can be carried on each wagon, giving a total capacity of 4400 gallons. Short rails are laid across the floor of the cars and the containers stand and run on these rails. Strong metal hooks and straps hold the containers firmly in position during rail transit.

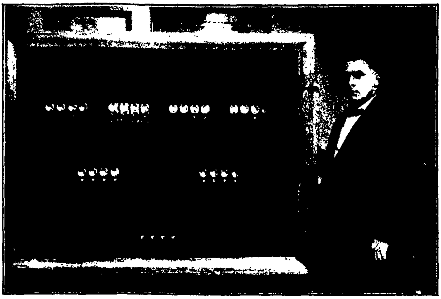
On arrival at destination the cars are spotted on sidings, permitting the road vehicles to back end-on to the rail car. As shown in one of the photographs, the trailer on which the oil containers are transported on the highway has two ordinary wheels at the rear and two smaller wheels at the front. Its body is composed of two rails long enough to hold two containers and strengthened to carry the weight required of them.

Down the center of the trailer runs an endless chain, which is operated by a handle in the rear. A hook at the bottom of each container fits into this chain, which is then moved to haul the containers one by one from the rail car on to the trailer. Stop blocks are fitted to the trailer to prevent the containers from over-running, while the locking of the endless chain insures that the containers are held fast during the period of road haulage. Braces, metal straps and blocks are also used to this end.

During the unloading of the rail car the small front wheels of the trailer are lowered to the ground, thus giving the body a slight downward tilt. This is of considerable assistance to the man operating the endless chain. When the two containers are in position on the trailer the front end is jacked up until the rails on the body are level. These movements are clearly shown in the illustrations.

On arrival at its final destination the front wheels of the trailer are again lowered to the ground, the trailer being disconnected from the tractive unit. In many cases the containers are run directly off the trailers and moved on their own wheels.

This system has a great advantage over the old method of fixed containers, since the railway wagons can be returned for reloading immediately after the containers have been removed and empty containers installed in their place, a matter of a few minutes only, thus saving the time previously occupied in discharging the contents of the large fixed containers. Moreover, by using tractors and trailers on the road the greatest possible use is obtained from the motor tractor units, which can thus be kept at work a large share of the time.



R. R. Graves, of the Bureau of Dairy Industry, with the "herediscope" which he invented to illustrate the transmission of hereditary characteristics

Herediscope is New Contrivance For Demonstrating Working of Inheritance

A MECHANICAL contrivance called a "herediscope" has been invented by R. R. Graves of the Bureau of Dairy Industry, United States Department of Agriculture, to aid in teaching the Mendelian theory of inheritance in dairy animals.

Inheritance, says Mr. Graves, is such a complex study that the average person is unwilling to expend the time and effort necessary to gain an understanding of the subject merely by reading about it. Furthermore, it is extremely difficult even for those well versed in the subject to write or lecture on heredity so that it can be clearly understood by those who have not made some study of the subject. By means of this newly devised machine, tentatively named "herediscope," it is hoped the most simple and fundamental principles of heredity can be more easily explained to livestock breeders, county agriculture agents, extension workers, students of genetics, and others whose work demands that they have some knowledge of the laws of inheritance.

The use of the herediscope need not be confined to teaching inheritance in dairy cattle. Fundamental principles of heredity are the same in plants, animals, and humans.

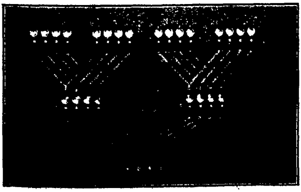
The machine consists of a number of groups of aluminum cups, each group representing an individual animal and arranged in the form of a pedigree showing three generations—four grandparents, two parents and one offspring. Numerous small, colored balls, each representing a given hereditary character, such as the "factors for high production of butterfat" or "low production of butterfat," are placed at random in the cups of the starting generation. When the operator presses a trigger connected with the mechanism, half of the character-symbols from each parent-cup are transmitted to the offspring, the selection of characters being merely by chance as is the case in actual matings. By repeated matings the observer is able to note how certain characters may be transmitted from generation to generation, or how they may be lost entirely in the process, how they may be present in an individual but covered up by dominant characters, and how in the absence of dominant characters they may again appear.

The machine will illustrate the transmission and recombinations of four separate characters, or it will illustrate the transmission of four multiple factors, in such types of inheritance as milk yield, egg yield, stature or other quantitative characters.

Specific need for a better means of teaching the theory of inheritance was brought to the attention of Mr. Graves when as a result of his inheritance studies on the records made by dairy cattle of the various breed associations, the theory was advanced that the proved prepotent sire that was transmitting uniformly high production was one that was pure in his inheritance for the factors controlling high production, and that if such sires could be used for several generations, a strain of cattle would eventually be bred that would be pure in their inheritance for high production.

It is not enough that a dairy sire be purebred or that his dam be a high producer. He must have an inheritance which is "pure for high production." In other words his germinal makeup must carry only those factors which cause high production; otherwise he would transmit low or average production to some of his daughters. Such sires whose germinal

(*Continued on page* 454)



This view of the "herediscope" shows the connecting channels by which the colored balls travel from one cup to the other. The apparently incomplete channels cross those which show here by means of hidden passageways

Learning To Use Our Wings

This Department Will Keep Our Readers Informed of the Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN
n School of Aeronautics, New York City

International Newsreel

To prevent the use of unsafe planes by "wildcat" pilots, the Post Office Department is burning up many of its disused De Haviland mail planes

Destroying for Safety

THE Air Regulations of the Department of Commerce provide a powerful aid to the safety of commercial flying. But the Department has jurisdiction only over flying between States and a pilot can operate without a license and without an airworthiness certificate for his craft provided he does so within the limits of one state.

The majority of the aerial service operators who conduct schools or carry passengers from a fixed base are experienced, conservative men who realize fully the necessity of every possible safety precaution and employ the soundest possible planes. There remain, however, a number of "wildcat" pilots, willing to purchase and operate disused government planes, no matter what the risk may be to themselves or their passengers.

It is somewhat hard for the public to differentiate between sound air operation and "wildcat" flying. It is therefore very gratifying to see that the Post Office Department, among other government agencies, is not selling its depreciated planes, but actually burning them up to prevent their reaching the hands of the "wildcat." The awe-inspiring photograph of the De Havilland mail plane in process of destruction by fire is one of the best auguries for the safety of commercial flying.

German Transatlantic Liners

THE Germans are taking an intense interest in the possibility of transatlantic airlines. Besides attempts to make the difficult crossing from east to west, powerful German shipping lines are said to be carefully organizing for a commercial service. Dornier and Junkers are also reported on good authority to be building "superplanes" for the same purpose.

Thus, Dornier at Friedrichshafen, on Lake Geneva, is said to be constructing an all-metal flying boat, which is to carry 100 passengers and to weigh 50 tons fully loaded, half of which will be useful load in the form of fuel, oil, passengers, crew and equipment. The power plant is to be of 7000 horsepower, in all probability with a number of engines arranged in tandem fashion along the wing, as is characteristic with Dornier construction. The hull is to be built ship fashion, with ribs, braces and partitions forming water-tight compartments.

Junkers, another famous German constructor, is also planning a 100 passenger ship, of very curious appearance. The plane will consist mainly of a large wing, with the elevators ahead instead of in the conventional tail position. In lieu of the tail rudders, two vertical surfaces will be placed at the tips of the wings, to be pivoted about a vertical axis when steering is required. There are thus radical aerodynamic changes in contemplation, involving a certain hazard. Four engines of 1000 hoursepower each will be employed, housed within the wing but protruding slightly forward of the leading edge.

On top of the wing, at its center, will be a cupola, in which will be stationed the captain, pilots and engineers. A long gangway, in itself a part of the wing structure, will traverse the entire span of the wing, with passenger cabins on either side. In addition to the cabins there is to be a social hall, dining room and baggage room. The entire structure is to be of duralumin, and the wing span is to be 120 feet.

(*Continued on page 465*)

Wide World

An artist's drawing of the proposed Junkers' superplane, equipped with four 1000 horsepower engines and designed to carry 100 passengers

INDUSTRIES FROM ATOMS

A Department Devoted to the Advancements Made in Industrial and Experimental Chemistry

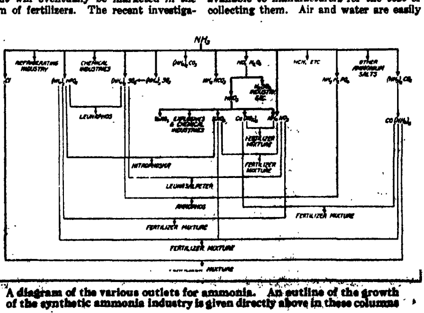
CONDUCTED BY D. H. KILLEFFER

Synthetic Ammonia

RAPIDLY increasing production of synthetic ammonia in the United States has attracted much attention. In a recent article in *Industrial and Engineering Chemistry*, V. N. Morris of the Fixed Nitrogen Research Laboratory, said:

"Less than six years ago the first successful synthetic ammonia plant in America started operation. Since then our progress along the line of nitrogen fixation has been commendable. At the end of 1926 eight plants in the United States were either producing or were ready to produce synthetic ammonia. Notwithstanding the possibility of supply surpassing demand, expansion and construction are continuing without sign of abatement. The Allied Chemical and Dye Corporation, for instance, has recently announced plans for a large plant to be erected at Hopewell, Virgina. It is understood that the output of this plant will go into fertilizers. It is also believed that a considerable expansion of the Lazote plant at Belle, West Virginia, is soon to be undertaken. It is known that part of the output of this plant will eventually be marketed in the form of fertilizers. The recent investigation of American conditions by German interests has made apparent another possible addition to the list of manufacturers of synthetic ammonia in this country. It is also worthy of mention that the plants of the Commercial Solvents Corporation and of the Great Western Electrochemical Company were scheduled to be completed and to start operation about the first of the present year.

"The accompanying chart gives a picture of the various outlets for ammonia. It shows certain potential ones as well as those actually developed. It should be borne in mind that nearly all the salts shown can, if marketed in a suitable physical condition, be used as fertilizers. The various uses of a given compound are not shown except in cases where omitting them would give the impression that the compound served only as an intermediate for the production of some other substance."



A diagram of the various outlets for ammonia. An outline of the growth of the synthetic ammonia industry is given directly above in these columns

Wanted—Cheaper Carbon Dioxide

OF all industrial raw materials, only three, air, water and carbon dioxide, are available to manufacturers for the cost of collecting them. Air and water are easily had almost anywhere but the cost of recovering carbon dioxide from flue gas or other sources is comparatively high. As new uses have been developing for it, a demand for more economical methods of getting it has arisen. On this subject, H. E. Howe of *Industrial and Engineering Chemistry* says:

"The latest use for carbon dioxide as a refrigerant opens up new opportunities in research. If solid carbon dioxide is to be universally used, a satisfactory system of distribution from carefully located plants must be developed, or the solid must be produced in numerous localities where carbon dioxide is normally available. It looks like an opportunity for power plants, especially where there is off-peak power available. The difficulty lies in the recovery of the carbon dioxide from the flue gases. These gases may contain say 12 percent CO_2 (carbon dioxide) whereas gases prepared for the purpose run approximately 18 percent. There is a real opportunity to devise economical methods of extracting carbon dioxide from the flue gases, utilizing off-peak power for liquefaction for the preparation of the refrigerant. There is also an opportunity to perfect improved methods for the manufacture of this gas as a primary product. It is another case of changed conditions calling for new developments, and proof of the well-known fact that, regardless of accomplishment, there is always much new work waiting to be done."

Ultra-Violet Light and Paint Weathering!

ULTRA-VIOLET light is known to have a serious effect on the lasting qualities of paints and its effect on the vehicles used in paints has recently been studied seriously by George F. A. Stutz of the New Jersey Zinc Company. In reporting his investigation at a recent meeting of the American Chemical Society, Mr. Stutz stated the following conclusions:

"A raw or untreated linseed oil is quite transparent. A heat-bodied oil is more opaque. A heavy-bodied, air-blown oil is still more opaque. In general, then, in the case of a bodied oil, the ultra-violet light is

(*Continued on page 469*)

Applied Science for the Amateur

A Department Devoted To the Presentation of Useful Ideas. Material of Value To All Will Be Found Here

CONDUCTED BY A. P. PECK

P and A

A group of winners in a model aircraft tournament held in California. Similar contests have been and are being held throughout the country. The columns below and on the following pages give instructions in the art of model aircraft building, and it is hoped that many of our readers will try the sport. Local contests between various types of aircraft models built by amateur aviation enthusiasts can be arranged by interested parties

ANNOUNCEMENT

RECENT developments in the applied science of aviation have brought with them a revived interest in the art of model aircraft building. Knowing that the knowledge gained by the study and construction of such models is of great value when the subject is to be pursued further, the Playground and Recreation Association of America has recently instituted competitions in various cities throughout the country in which homemade model airplanes are to be entered.

In order to dessiminate the available information on model construction so that all may try their hand at this interesting and instructive hobby, the above mentioned society has prepared a series of illustrated articles which will appear every month in this department, beginning with this issue and running until further notice. These articles will describe all of the various types of model airplanes, beginning with the simplest glider, and going on to more complicated rubber-band propelled types. There will also be included the design of one model using compressed air for the source of power.

We invite all of our readers to try their skill at this new hobby. We have on hand a list of places where materials for model work can be obtained, and also where further information on the subject may be had. This information will be forwarded to interested parties on request. To further the work and to show our readers what is being done by others, we offer to print, when space allows, photographs and short descriptions of models made, either from our articles or from original designs.

The Editor.

Tools and Materials for Model Aircraft Construction

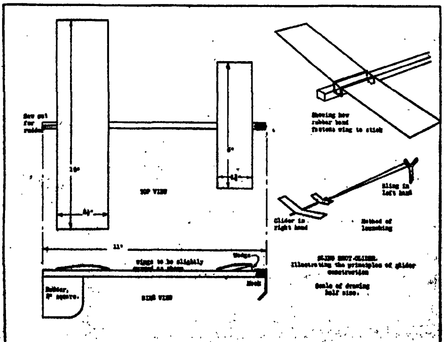
FEW tools are required in the making of model airplanes. A good sharp pen-knife is perhaps the most useful tool. This should be very sharp, and one of the blades should be well pointed. For some delicate cutting, a razor blade is preferable to a pen-knife. A ruler is, of course, essential. If possible, the model maker should equip himself with two pairs of pliers, one being of the round nose variety for use in forming hooks and other wire fittings, and the other should have a flat nose and a cutting edge on the side.

A small sharp plane will often come in handy for dressing down wood. A very suitable type of plane is known as the Stanley 75, although suitable planes may be purchased at the ten-cent store. For drilling the holes in propellers a number sixty twist drill is used. This can be rotated either in a hand drill frame or in a small "pin vise" such as may be purchased from a jewelers' supply house. Two other requisites are a candle and a piece of sand paper about number 0 grade. The above tools will enable anyone to make good models. Should the model maker have access to a woodworking shop, the use of a small circular saw and a band saw will make it much easier for him to cut out strips and propeller planks.

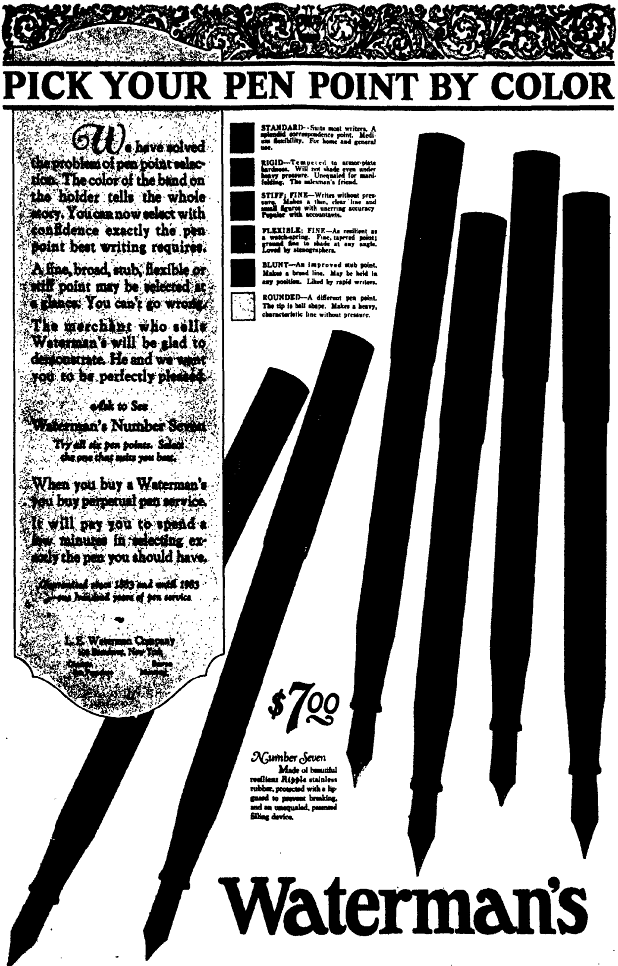
Materials for model aircraft construction may be grouped under four heads, namely, wood, metal, fabric and liquid. The woods used are pine, spruce, bamboo and balsa. Pine is, of course, very easy to obtain as it is the common wood used for packing, crating, and house construction. Straight grained, well seasoned pieces should be selected, and these may be either sawed or split to the proper size. Spruce is superior to pine because of its lighter weight and greater strength, but it is seldom used for packing or building and can, therefore, probably be purchased only at lumber yards.

Bamboo is a hard, light wood which is particularly recommended for model building because it possesses unusual strength, can be split to the proper sizes and, when

(*Continued on page* 463)



Detailed views of the glider described in these columns



PICK YOUR PEN POINT BY COLOR
We have solved the problem of pen point selection. The color of the band on the holder tells the whole story. You can now select with confidence exactly the pen point best writing requires.
A fine, broad, stub, flexible or stiff point may be selected at a glance. You can't go wrong.
The merchant who sells Waterman's will be glad to demonstrate. He and we want you to be perfectly pleased.
Ask to See
Waterman's Number Seven
Try all six pen points. Select the one that suits you best.
When you buy a Waterman's you buy perpetual pen service.
It will pay you to spend a few minutes in selecting exactly the pen you should have.
L. E. Waterman Company
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STANDARD—Suits most writers. A splendid correspondence point. Medium flexibility. For home and general use.
RIGID—Tempered to armor-plate hardness. Will not shade even under heavy pressure. Unequaled for manifolding. The salesman's friend.
STIFF; FINE—Writes without pressure. Makes a thin, clear line and small figures with unerring accuracy. Popular with accountants.
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ROUNDED—A different pen point. The tip is ball shape. Makes a heavy, characteristic line without pressure.
$7.00
Number Seven
Made of beautiful red lined Ripple stainless rubber, protected with a lip-guard to prevent breaking, and an unequaled, patented filling device.
Waterman's

Strays From the Ether

A Monthly Review of the Progress Made In All Branches of Radio Communication

CONDUCTED BY ORRIN E. DUNLAP, Jr.

WEAF Modernized

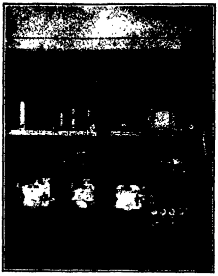
STATION WEAF's new transmitter at Bellmore, Long Island, representing the latest in broadcasting apparatus and an investment of approximately a half million dollars, is now on the air. The power output is rated at 50 kilowatts, which, according to Dr. Alfred N. Goldsmith, Chief Broadcast Engineer, can be depended upon to give reliable service within a radius of 100 miles under all conditions.

The 250-foot aerial is held aloft by two lattice steel towers each 300 feet in height. A vertical lead-in is taken off the center of the aerial proper, thus forming a "T." The towers will be illuminated by flood lights at night to serve as a beacon for aviators and to serve as a warning lest the planes run into the masts or wires over the flat Long Island countryside.

The equipment is located in a one-story stucco building midway between the towers. The power furnished by the Long Island Lighting Company is fed into the installation at 250 kilowatts, according to the engineers. It is said to be sufficient to light 10,000 homes. The electricity employed to light the filaments of the big transmitting tubes would supply enough current to operate the filaments of 200,000 UX-199 receiving tubes, or approximately 50,000 of the average dry battery receivers now in use. The energy utilized to supply the plate curcuit of the transmitter would provide sufficient "B" voltage for 550,000 UX-199 receiving tubes.

An Electrical Set

A NEW radio circuit incorporated in two different cabinet styles and 100 percent electrically operated, was introduced recently in New York by the Kellogg Switchboard and Supply Company. Improved alternating current tubes are utilized so that the set is operated in connection with the light socket, thereby dispensing with all batteries. There are seven alternating current tubes of the



The white arrow points to the quartz crystals which hold WEAF on its exact wave length. Only one crystal is used at a time, while two others are held in readiness to be switched into the control circuit

Kellogg heater type. The circuit comprises four stages of tuned radio-frequency amplification, detector and two audio stages. The tubes are the same type throughout except in the last audio socket in which a new alternating current power tube is employed to handle volume without distortion.

The internal part of the instrument is divided into six sections, each of which is housed in a metal box to prevent interaction between the circuits and to aid in making the circuit a sharp tuner. Five of the metal compartments contain the radio frequency tubes with their associated coils, and the detector separately boxed. The sixth box contains the audio amplifier unit.

An individual metal box contains all the power equipment, including a small step-down transformer and "B" eliminator with a 313 type tube. The maximum "B" or plate voltage supplied is 215.

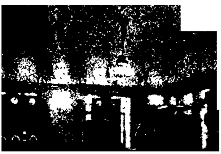
An aerial condenser is provided so that the receiver can be adjusted to work with maximum efficiency with any length antenna. This adjustment is made inside the cabinet, and once effected, the control need not be touched unless the antenna is altered.

There are two tuning controls, one a group switch that regulates the stator windings of the secondary coils, and the other a simultaneous control for the rotors of the coils. A small knob controls the volume, which can be regulated from a whisper to an intensity sufficient to fill a large auditorium with music of high quality.

The set is built in two models, a consolette and in a large Italian Renaissance cabinet with a novel arrangement of the door panels, which can be closed to conceal the radio panel when the set is not in use. An external cone loudspeaker has been designed to work with the consolette, while a built-in loudspeaker of the compositon horn type with a 60-inch air column is used with the large receiver. The tubes are mounted on cushion sockets to prevent microphonic noises.

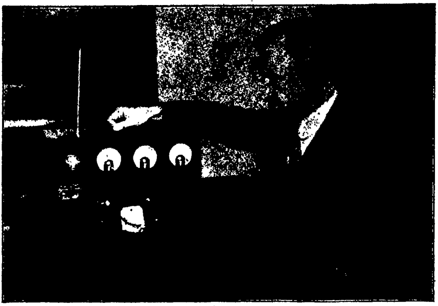
Wells A Pessimist

that there may soon be a grave dearth of



At the left is the crystal-control apparatus that holds WEAF to a frequency of 610 kilocycles. At the right are five stages of high-power radio-frequency amplification

Thirty-two high-power tubes used in the new 50-kilowatt installation of WEAF at Bellmore, Long Island. The modulator tubes are located at the far end of the room



Dr. J. H. Dellinger, chief of the Radio Laboratory of the United States Bureau of Standards, demonstrating a piezo-electric oscillator or wavemeter

listeners. I suggest that the whole broadcasting industry will begin to dry up. Recent public discussions in the British press about broadcasting are significant symptoms. They reveal widespread discontent among current users of receiving sets. The transmitting authorities, still unwilling to face the plain intimations of destiny, are trying all sorts of novelties nervously and assuredly. My discouraging forecast is mingled with regret," so says H. G. Wells in his prediction that radio will pass away with the "cross-word puzzle and Oxford trousers."

So far no one has been found in America who agrees with the novelist. One prominent radio man suggested that Wells get a new set and a good loudspeaker; another called him by implication an "intellectual snob" and put the British writer in the class of the "intellectually overfed or the spiritually jaded," who laughed at the early automobile, telephone and steam engine.

It is apparent that Wells stands alone on this point, while radio continues to win new followers as the audience moves upward to 7,000,000 and the industry reaches the billion-dollar class.

Industry Expands Into Billion Class

THE radio industry has reached a point in industrial activity where not only its rapid development but its actual size makes it of commanding importance, according to Frank A. Arnold, Director of the Development of the National Broadcasting Company.

Mr. Arnold reports that the radio industry directly and indirectly gives employment to 300,000 people while 3500 manufacturers, distributors and jobbers attend to the making and selling of radio sets and parts.

"In 1920 the annual sales of radio amounted to 2,000,000 dollars," said Mr. Arnold. "During 1926, the sales reached 500,000,000 dollars, while the total sales credited to the industry for the period 1920 to 1926 inclusive are summed up to be 1,493,000,000 dollars—a billion dollar industry developed in six years.

"Out of 27,000,000 homes in the United States, 6,000,000 have radio receivers, leaving 21,000,000 homes to be equipped. Out of 950 broadcasting stations in the entire world, 678 are operated in the United States. Figuring an average of five listeners to a set, there is a potential audience in the United States of 30,000,000 people within the range of a human voice."

Arlington Time Ticks on Four Channels

ARLINGTON'S time signals are now given world-wide distribution by broadcasting them on four wavelengths instead of one as heretofore.

At 11.55 and 9.55 P. M., Eastern Standard Time, the time ticks of the nation's master clock in the Naval Observatory are radiated on 2678, 73.33, 37.25 and 24.8 meters. Each second's tick forms a dot on the radio.

The 29th second of each minute is omitted to make clear the passing of the half-minute. The last five seconds of the first four minutes are also omitted to make noticeable the passing of each minute. The last ten seconds of the fifth minute are not radiated. A dash at noon and 10 P.M. denotes the hour.

Station NSS, Annapolis, sends out the Arlington time signals on 17,130 meters.

Bellows Sounds Warning

COMMISSIONER H. A. BELLOWS points out that two dangers threaten the radio field today. The first is that the public demand for quality and service will progress more rapidly than the ability of the stations to keep pace with it, while the second is that the listeners will become bored and surfeited with the programs they are receiving before the broadcasters are aware of it.

The first of these dangers, he says, can be averted by the electrical manufacturers exploiting the field to a greater degree than they have done in the past by offering more programs. The second danger is harder to deal with as it often happens that the broadcaster has no certain or definite means of checking up the public's reaction to his programs.

The future of radio manufacturing depends largely upon the progress of broadcasting, and this progress in turn depends upon the broadcasters' understanding of the public's demand. Commissioner Bellows suggests that it is a problem that the manufacturers themselves must solve by studying the wants of the public. He points out that this demand is not unreasonable inasmuch as the manufacturers provide so small a percentage of the broadcasting upon which every dollar of their business depends.

British Relay WGY Dance Music

EVERY Tuesday night when air conditions are favorable, Keston, the listening post of the British Broadcasting Company, relays dance music from 2XAF, the short-wave station of WGY, Schenectady.

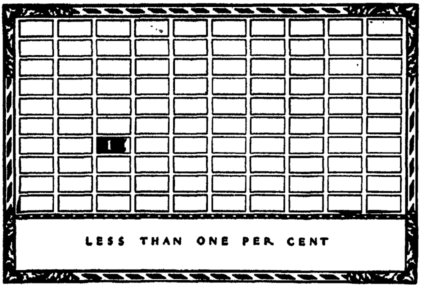
"Sometimes the music, apart from periodic fading, is as good as that from the Savoy Hotel, London, but on occasions the interference from atmospherics is so severe as to spoil the relay and render the remarks of the American announcer unintelligible," reports a British observer. "But these relays have drawn the attention of British listeners to the remarkable ease with which short-wave transmissions from America can be heard direct on one and two-valve sets. Some results can be obtained on most nights in the small hours and occasionally the quality and volume approach those of the local stations except for slight fading."

Balloon Up 31,000 Feet Gets Radio Concert

THE question whether or not radio waves travel far up in the sky has been answered by Captain H. C. Gray, who recently climbed 31,000 feet above Scott Field in a free balloon. He listened in with a broadcast receiver and picked up concerts from KSD and KMOX, St. Louis, hearing them clearly until the altimeter registered 31,000 feet, when he began the six-mile descent.

Captain Gray did not listen during the drop because he was too busy preparing to make a parachute jump. He reported no static at the high altitude, where the temperature was 70 degrees below zero.

The Reisz microphone, developed in Germany, is known as the "variable contact" type. It has no diaphragm, the sounds impinging directly upon a powdered conductor between two fixed electrodes

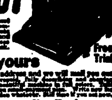


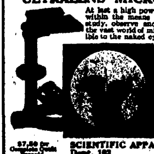
An Advertisement of the American Telephone and Telegraph Company

No ONE person owns as much as 1% of the capital stock of the American Telephone and Telegraph Company.

The company is owned by more than 420,000 people, with stockholders in every section of the United States. It, in turn, owns 91% of the common stock of the operating companies of the Bell System which give telephone service in every state in the Union, making a national service nationally owned.

The men and women owners of the American Telephone and Telegraph Company are the largest single body of stockholders in the world and they represent every vital activity in the nation's life, from laborer and unskilled worker to wealthy and influential executive. Although the telephone was one of the greatest inventions of an age of large fortunes, no one ever made a great fortune from it—in fact, there are not any "telephone fortunes." The Bell Telephone System is owned by the American people. It is operated in the interest of the telephone users.





The Scientific American Digest

(*Continued from page 443*)

makeup is pure for high production are few and far between, but apparently they do exist. Unfortunately they can not be distinguished from sires whose germinal makeup is mixed, except by noting the production records of a large number of their daughters. When a sire is found to have a large percentage of his daughters in the high-production class, he is considered to be pure in his germinal makeup and is termed a "proved" sire.

Proved sires are being located by examining the records of cow-testing associations, bull associations, and individual herds. Such sires are retained for active service as long as possible. Until the average dairyman gains a better understanding of the laws of inheritance, however, he is not likely to realize the importance of the proved sire. One illustrated lesson with the herediscope should make it possible for him to see why the so-called proved sire is the most certain and speediest moans of developing high production in dairy cattle.

As yet there is but one herediscope in existence, the one made by Bureau of Dairy Industry engineers for Mr. Graves. Some of the mechanical features were designed by K. E. Parks and the machine was built by G. F. Betz. It may be possible to simplify the mechanism so that herediscopes can be produced without excessive cost, and small enough in size to permit their use in various places where county agents or extension workers find it necessary to talk on inheritance.

Beryllium, New Light Metal, Promises to Rival Aluminum

AIRSHIP frames and light-weight pistons may soon be made from beryllium or its alloys, and this hitherto little known metal may soon achieve the household familiarity that aluminum has won during the last two or three decades.

Beryllium is a metal about a third lighter than aluminum, but is very much harder, scratching glass easily, like hard steel. According to H. S. Cooper, industrial chemist of Cleveland, Ohio, who has been conducting extensive experiments, it is one of the most remarkable of all metals in its elasticity. It is over four times as elastic as aluminum, and 25 percent more elastic than steel. And while aluminum corrodes easily on contact with salt water, beryllium shows very high resistance to this as well as to other metal-destroying liquids and fumes. It is light gray in color, and takes a polish like that of high grade steel.

It is chemically related to aluminum, and easily forms alloys with it. One of these, consisting of 70 percent beryllium and 30 percent aluminum, is one-fifth lighter than aluminum, far more resistant to corrosion, and in tensile strength far exceeds duralumin.

One quality, which Dr. Cooper points out, may render beryllium especially valuable to the automobile industry. It expands under the influence of heat at about the same rate as cast iron. Thus, when used for light pistons inside the iron cylinders of automobile engines, it will present far less engineering difficulty than do the present types of light pistons, which expand at a rate different from that of iron.

Beryllium ores are found abundantly both in this country and abroad. At present they are hauled out of feldspar mines in New England by hundreds of tons, but are dumped away as waste. The commonest type of ore is known as beryl, polished crystals of which are someti worn as semi-precious stones.

Although so new industrially that it can not properly be said to have been born yet, scientifically, beryllium is an old story. It has been known to chemists for 130 years; Vauquelin, a Frenchman, first indicated its existence in 1797. But until recently it has remained merely a museum curiosity and a laboratory material, because it is so refractory that the cost of getting it in anything like a pure state has been prohibitive. But now that the cost of manufacture promises to be materially reduced by a new electrolytic process, it is probable that it will appear on the market in quantity within a few years.—*Science Service.*

Old-Fashioned Carbon-Filam Lamps Die Hard

THE National Electric Light ciation has made the surprising di covery that 18,500,000 carbon-filame lamps were sold in this country last year, despite the fact, which everybody knows, that the tungsten filament is much over twice as efficient as a ligh source. Of the 18,500,000 lamps, 500,000 were for legitimate special purposes, such as indicator lamps and for heating, resistances, and so on; 2,000,000 also were purchased because ce filaments are more rugged than ordi tungsten filaments. This leaves 16,000,000 lamps, which were purchased on ac count of initial low cost or for othe reasons. Every one of those 16,000,000 lamps is a source of unneces an economic loss, because it must operate at low efficiency. In most ca good coal had to be burned just to n up for the low efficiency of the carl filament lamps as a light giver, in c parison with tungsten lamps—a wi waste of resources.

A new "rough service" tungsten-filament lamp has now been developed. It will withstand much more abuse than the ordinary tungsten lamp, and, it now appears, it also will take more punishment even than the carbon-filament type. To test this point, the new lamps were placed in a guard and socket and attached to the end of a cord. Then they were dropped repeatedly from a table three feet high. The average of a large number of tests showed the following results: 60-watt carbon-filament lamps, 22 falls; 50-watt, rough-service, tungsten-filament lamps, 55 falls.

As an interesting side light, it was discovered that very light guards are best. Heavy guards increase the breakage, instead of decreasing it.

The Cosmic Ray

FREQUENTLY the editor receives requests for information concerning the cosmic ray which Dr. R. A. Millikan described in an article in the March, 1926, issue of the SCIENTIFIC AMERICAN. Has it yet been definitely established how the cosmic radiation originates, and where? The following note by B. P. Gerasimovic

is extracted from a publication of the Harvard College Observatory.

"Although the cosmic origin of the high-frequency radiation recently observed at great altitudes seems to be definitely established, there is considerable diversity of opinion among experimental physicists as to its nature and general character. Millikan found that within the limits of uncertainty of measurement, cosmic rays traverse space equally in all directions. On the other hand, Kolhörster four years ago detected daily variations in penetrating radiation, and suggested that the Milky Way, and the regions of Andromeda and Hercules at culmination, are responsible for the maxima of rate of ionization registered by his electroscopic camera. Observations made in the summer of 1926 at the top of the Mönchgipfel, 4100 meters above sea level, by Kolhörster and von Salis seem to confirm this opinion, though their observations on the Eigerwand did not show any noticeable daily variation. The observations made by Buttner and Feld on the top of the Zugspitze, 2830 meters above sea level, during the fall of 1926 and the spring of 1927, established a direct dependence of maxima and minima upon sidereal time, and gave daily curves in agreement with those of Kolhörster. The amplitude of the variation was only 8 percent of the whole penetrating radiation."

The whole question is therefore still in a controversial state; a satisfactory solution can only be given by the experimental physicists.

Finds Tooth Brush Pyorrhea Peril

THE old family tooth-brush is again under indictment with none less than Dr. F. D. Donovan, surgeon dentist to the British royal household, leading the attack.

Practically no tooth-brush in current use is free from germs, declared the guardian of the royal molars in a recent report to the medical journal *Lancet*. He has examined bristles from hundreds of them, including his own, under the microscope with disturbing results.

While pyorrhea is not actively caused by the unclean brush in Dr. Donovan's estimation, he nevertheless believes that it is at the root of 90 percent of the cases now prevalent in the civilized world. Keeping brushes immersed in a one-to-twenty solution of carbolic acid when not in use is the only practical method he has found of keeping them sterile. This is hard on the brushes and fine for the manufacturers, he admits, but is the only remedy he can see at the present time to check the prevalence of the infection.—*Science Service.*

How Athletics are Conducted in Great Britain

"GAMES and Sports in British Schools and Universities" is the title of Bulletin 18 of the Carnegie Foundation for the Advancement of Teaching. The author, Dr. Howard J. Savage, staff member of the Foundation, spent several months in Great Britain gathering materials for this first American descriptive study of athletics in British educational institutions. The Bulletin describes sport in its relation to education at English public and day schools, Oxford and Cambridge, the newer English universities, like London, Liverpool,

Leeds, and Birmingham, and the universities of Scotland and Ireland.

It also discusses British athletic tradition and presents probably the first historical summary of the status of the amateur in England. There are a few comparisons with conditions in America, but since the Foundation is at present engaged upon a study of American school, college, and university athletics, most of these comparative considerations are deferred.

Some of the conclusions of the study may be summarized as follows: Athletics in British schools and universities are valued partly for their physical effects but more for their socializing influences. Although they are not formally recognized by any university, they are aided by Oxford and Cambridge colleges and by many of the newer universities. Most schools insist in one way or another, upon participation in games, but no university compels any undergraduate to take part. "At all universities, sport is essentially casual." Athletics are subordinate to studies, but the lessons learned on the playing fields are carried over into all phases of school and university life, inside the classroom and out.

While personal athletic prowess is highly esteemed, the reputation that victories can bring to institutions counts for comparatively little. Participation being play in the strict sense of the term, the line between the amateur and the professional has come to be strictly drawn in most branches of athletics, nominally drawn in all. Very few persons are dependent upon school, college, or university sport for their livelihood, and no such person, whether coach or trainer, depends upon victory for his living.

Copies of this Bulletin and of the Twentieth Annual Report of the Foundation, which on pages 132-136 deals with American college athletics, may be had without charge on application to the Carnegie Foundation, 522 Fifth Avenue, New York City.

Row of Monuments May Reveal Future Earthquakes

EARTHQUAKE prediction, commonly regarded as an innocent form of humor, promises shortly to find a solid scientific basis, according to the plans of Dr. John P. Buwalda, head of the new department of geology of the California Institute of Technology. The Institute, in cooperation with the Carnegie Institution of Washington, is embarking on an extensive program of laboratory and field research on earthquakes. The plan, which involves large financial outlay, will cover southern California. While there has never been extensive damage from earthquakes in this end of the state, it is hoped that definite scientific data may be secured in order to determine whether or not a major quake is in the making, and if so, where.

Dr. Buwalda tentatively rejects the old idea that a great rock mass may rest silently and immovably under great pressure until some fateful hour when it suddenly cracks and precipitates a disastrous quake. Instead, he takes the position that any really dangerous line of rock slippage would already show a

crack or "fault" line, in which the two abutting rock masses, temporarily stuck together, would gradually be deformed under a shearing pressure during the period of years prior to a serious earthquake. The situation might be likened to an attempt to slide one piece of stiff taffy past another—as long as the two cohesive masses stuck together, a slight distortion or semi-liquid flow would occur along the crack between them while the sliding pressure was gradually being applied.

Dr. Buwalda plans to set a number of monuments in a very precise straight line directly across a suspected earthquake fault. Provided the original survey is highly accurate, the geologist may determine within five or ten years whether the row of monuments has been twisted out of line. The distortion would have to show an S-pattern, and not a direct break from line, if the geologist is to regard the situation as dangerous. If no actual curves are observed, no great earthquake is in prospect; if there is distortion, then it is time for the city council to revise the building code and begin to brace old buildings. The actual disaster would be ... release of ... distorted spring and that of its potential energy.

Other apparatus is being designed to record upward tilt of rock as well as the side thrust. Improved seismographic records will be kept not only at the central laboratories at Pasadena but at widely scattered stations all over southern California. Eventually telegraphic communication is to be effected between these stations so as to afford trustworthy information on earthquake velocity.

This research program is of considerable interest to insurance companies now being solicited for large amounts of earthquake protection. Under present conditions such companies are totally at a loss to estimate hazards, and a single disaster could easily wipe out a hundred years of ordinary premiums or bankrupt the concerns.—*Science Service.*

California Redwoods Thrive in Washington

REDWOOD trees, imported from California and planted in the Grays Harbor district of western Washington 14 years ago by one of the large logging concerns of the Pacific northwest, have proved a pronounced success, according to company officials. As a result, plans are under way to transform large areas of cut-over lands in the Grays Harbor section into redwood forests.

In the 14 years, a redwood tree has attained a diameter of 18 inches, showing more rapid growth than that of any other variety of tree planted at the same time. The tree also shows every indication of being high-grade lumber stock. Other varieties planted included spruce, fir, pine, and red and white oak. Encouraged by these results, the company is undertaking the growing of the redwood trees from seed, and in addition has planted more than 1000 acres with spruce, fir and pine seed. Success in these seeding operations will lead to reforestation on a large scale, lumber officials say.—*Science Service.*

Industries From Atoms

(Continued from page 446)

absorbed almost entirely at the surface. A raw linseed oil, however, allows the light to penetrate a considerable distance befo[re it] is completely absorbed.

"On exposure to the mercury arc, o[r] sunlight, a film of raw linseed oil becomes more transparent (bleaches). A film of air-blown oil also bleaches, although not so much as the raw oil film. A heat-bodied oil film, however, shows but little change and may even become more opaque on exposure to the ultra-violet light. This leads to the conclusion that, in the case of a raw oil, a material is produced on drying and aging, which is acted on by ultra-violet light in such a way as to convert it into some other material more transparent to ultra-violet light. In the case of a heat-treated oil, an opaque material is produced on drying and aging, which is not changed to a more transparent form when acted on by ultra-violet. Instead the ultra-violet light may accelerate the formation of the opaque material. An air-blown oil would seem to contain some of each of these materials since it is rendered somewhat more transparent by exposure to the ultra-violet light.

"Perilla oil becomes more transparent on exposure to the ultra-violet light. China-wood oil also becomes slightly more transparent. Poppy and soy-bean oils becomes more opaque in the near ultra-violet and more transparent in the far ultra-violet.

"All the varnishes measured are quite opaque. Moreover, on exposure to ultra-violet light they become more opaque (yellow). The tendency to yellow is least in the case of a long oil varnish high in linseed oil and is greatest in the case of a short oil varnish high in China-wood oil. Apparently the gums present are largely responsible for the yellowing of the varnish as well as its high initial opacity.

"The results for lacquers show that clear nitrocotton is quite transparent. The addition of a plasticizer renders it more opaque at the shorter wave lengths. This is true of all the plasticizers commonly used. The further addition of gum renders the lacquer still more opaque. Also, ester-gum is much more opaque than dammar. Exposure of the lacquer film to ultra-violet light or sunlight results in the formation of a deep yellow color and a corresponding tremendous increase in opacity to ultra-violet light.

"Practically all vehicles have high absorption at the shorter wave lengths, below the limit of the sun's spectrum. Therefore, whenever a vehicle film is exposed to a source of short ultra-violet radiations (2800 Angstrom units or less) the energy is practically all absorbed at the surface. Thi[s] accelerates decomposition, hardening, an[d] similar reactions at the surface only, the underlying film not being affected.

"On the contrary, when exposed to sunlight, the radiations, being above 2900 Angstrom units, are sometimes able to penetrate a considerable distance into the film before being completely absorbed. This difference should be considered in interpreting accelerated weathering results where the light source used is one rich in the short wavelengths beyond the limit of the sun's spectrum."

Vitamin E in Cod-liver Oil

VITAMINS, essential factors in our food, have received much attention in recent years. The only methods of detect-

ing their presence has been by feeding experiments with animals. A recent investigation in the laboratory of Iowa State College by Nelson, Jones, Adams and Anderegg had to do with the detection in cod-liver oil of the vitamin necessary to reproduction. In reporting their finding to the American Chemical Society, these investigators state:

"Considerable interest has been manifested during the past few years concerning the existence of a substance designated as vitamin E. Supposedly this unknown dietary factor is required for normal reproduction, and in its absence animals become sterile, although they may grow to full adult size at the normal rate."

After extensive experimental feedings under various conditions, the following conclusions are reached:

"Reproduction results obtained with cod-liver oil depend upon the manner in which the oil is administered.

"Reproduction is much better on synthetic diets containing cod-liver oil than on synthetic diets with filtered butter fat. If the animals on the synthetic diet containing butter fat have a low hemoglobin content (and such may be the case) whereas those on cod-liver oil have a normal erythrocyte count and hemoglobin content, then there is present in cod-liver oil a specific vitamin which is required for normal iron metabolism. This conclusion is based on the supposition that the results of Hart, Steenbock, Elvehjem, and Waddell are correct—namely, that their animals suffering from anemia received a sufficient quantity of vitamins A, B, and C; and that ultra-violet light did not remedy the condition. This problem is now under investigation in this laboratory and results will be published when they are complete."

Re-Refining Dry Cleaners' Naphtha

DRY cleaning in the United States consumes about thirty million gallons of naphtha per year and the cost of this is one of its largest items of expense. A process for recovering used naphtha for re-use has recently been developed which will reduce this item of cost considerably. In describing the new method before the American Chemical Society, its inventors, Flowers, McBerty and Dietrich, of the De Laval Separator Company, said:

"The method consists of treating part of the solvent used continuously to remove

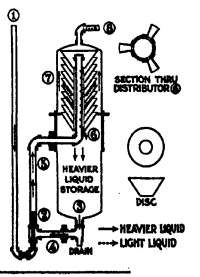


Figure 1

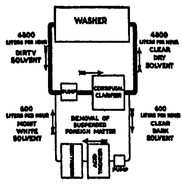


Figure 2

water and suspended dirt followed by treatment with sulfuric acid and alkali to remove color. A new type of self-contained apparatus had been developed for carrying on reactions between a continuous stream of one liquid and a second liquid or a solid. (Patents on this apparatus are pending.) The essentials of this equipment as constructed for bringing about the reaction between a 20-liter charge of concentrated sulfuric acid and a 600-liter per hour stream of used cleaners' solvent are shown in the schematic cross section, Figure 1. A duplicate of this apparatus, except that high-chromium steel disks are provided to prevent rusting, is used for the second step in the process—neutralization with an alkaline solution containing free ammonia. The tanks required for the 600-liter per hour units now available are 35 centimeters in diameter by 125 centimeters high. The acid-treater and neutralizer together occupy a floor space 1.5 by one meter and require 2.5 meters of head room. In this equipment provision is made for drawing fresh charges of chemicals into the respective tanks by establishing a partial vacuum in them by means of a small vacuum pump.

"The principle of operation of this equipment is as follows: The solvent stream enters at (1) Figure 1, through the mixing nozzle (2). The chemical reagent flows from the storage space (3) through the pipe (4) and mixes with the solvent stream in the pipe (5). The mixture of the two liquids rises into the distributor (6) in much the same manner as the mixture of air and water rises to the surface in the air-lift pumping of deep wells. The distributor (6) sends the mixture into the disk-stack (7), which provides about 2.2 square meters of settling area in which the heavier component is required to fall a maximum of 7 millimeters before it strikes a disk surface, on which it collects and down which it flows to drop finally back into the storage space (3). The solvent stream, now carrying not more than 0.05 percent by volume of acid tar (or about 0.15 percent of neutralizing solution) flows upwards past the periphery of the disks and finally out through (8).

"The refining of used cleaners' solvent by means of sulfuric acid is, of course, only practical for a solvent from which suspended dirt and moisture have already been removed. Furthermore, since the neutralized light-colored solvent may entrain about 0.05 percent of aqueous solution, it cannot be admitted to the washer until this has been removed. To meet these conditions a circulating system, shown schematically in Figure 2, is used.

"The decolorizing operation costs about 0.5 mill per liter, as shown by data from

eight months' experimental plant operation, during which time 5000 kilograms of clothing, blankets, rugs, et cetera, were dry-cleaned."

Non-Toxic Cotton-seed Meal

COTTON-SEED meal has a high nutritive value when used as a stock feed, but unfortunately it contains a material, called gossypol, which has a deleterious effect upon animals to which it is fed. This constituent of cotton-seed meal is decidedly toxic and very difficult to remove. A recent investigation by Willis D. Gallup at the Oklahoma Experiment Station has shown that steaming either the seeds or the meal for a longer period than is customary in oil mills destroys this toxic principle and yields a feed of high value. This discovery opens the way for a much larger use of cotton-seed meal than has heretofore been practicable.

American Possibilities in Growing Rubber

AMERICA'S dependence on foreign sources for necessary raw materials is frequently emphasized. Perhaps the most important of these is rubber. Mr. Samuel Wierman, in commenting on this situation in *Industrial and Engineering Chemistry*, points out that there are many latent possibilities of American independence so far as rubber is concerned in tropical America. He goes on to say:

"One is impressed with the fact that in tropical America are vast areas of land with suitable soil and climatic conditions for the growth of all tropical products required by the United States. Much of this land is north of Panama and but a comparatively short haul from our centers of industrial activity. All these areas are capable of being connected with the existing railroad systems without prohibitive cost.

"The principal objection against development of these areas seems to be the high price and scarcity of labor. But is this such an overwhelming handicap as to jeopardize our supply of essential raw materials in time of national stress? Obviously, one cannot expect to find in any part of the world vast areas of available land and also an abundant population. If the population is there, then the land is occupid by it. In Malaya the labor for the rubber plantations is imported from British India, at least five days' sea journey distant. In Sumatra the labor for the plantations is imported from the thickly populated island of Java. In neither place has much success attended the efforts to colonize a resident labor force.

"Is not this difficulty of labor unduly stressed? Cannot much if not all, of it be overcome by organization and intelligent direction? Today, rice, the food of Oriental coolies, is being shipped from California to the Orient with the cost of a 30-day sea haul added to it.

"For good or ill, the destiny of our neighbors to the south of us is bound up with the United States. Instead of sending millions of dollars across the seas for the development of foreign countries, why not direct this creative force to our American neighbors and help bring to them prosperity by assisting them to develop their wealth of natural resources while at the same time insuring ourselves against any interruption of supplies of raw materials."

Applied Science for the Amateur

(*Continued from page 448*)

heated, can be made to form various shapes. Bamboo comes in poles. These may be obtained either as fish poles or as rug poles. Hardware and sporting stores usually carry the former, and the local carpet merchant would probably have the latter. A discarded porch screen may be found to be made of bamboo. A few lumber yards carry this wood.

Balsa wood is extremely useful in the building of the finer grades of models because it is very light and can be easily worked. Physically speaking, it is lighter than cork and one-half as strong as spruce. It has practically no grain. This wood is not at all common. Should the model maker be near a flying field, he may be able to obtain some from the men there. Balsa wood may also be purchased in pieces 40 inches long, 5 inches wide and 2 inches thick for 75 cents each. It should be emphasized that balsa wood can be properly cut only by the sharpest tools and the strips from the saw should be lightly sanded with sand paper.

Metal is used for several of the model aircraft fittings. Small nails are used for propeller bearings on the light models. These are hammered into shape as will be explained in a near future article. Other fittings are made from small piano wire, which is obtainable at music and hardware stores. Sizes number 10 and 15 used, and a coil of each will provide m: fittings. It is suggested that the exe tives purchase this wire in coils from which the boys can secure pieces. Because this wire is so hard, it can be cut only by very strong pliers or special wire cutters. These special tools perhaps be borrowed. Should pian be unobtainable, domestic wire articles can serve as substitutes. Paper clips and hair pins will do for the smaller fittings, where stiff wire is needed, as in the propeller shafts, hat pins are useful. Ten-cent stores usually handle these articles. In order to reduce friction between the propellers and their bearings, small washe are used between. These are number 14 washers, procurable at any hardware store. Dress spangles also make excellent washer and are smaller than the ones just mentioned. Spangles are a notion store product. These are very cheap; ten cents will buy enough for a dozen models.

Occasionally fine steel wire about number 32 will come in handy for binding small pieces of wood and fittings together. Hardware stores carry this. In the scale models, fittings for holding struts, etc., are often made out of pieces of metal tubing. This can be procured in the larger hardware stores, and often scraps are obtainable in garages. On scale models and occasionally on scientific models, metal can be soldered together to produce strong joints. This method, because of its weight is, however, seldom employed. If the model maker does not already know how to solder, he will find this ability occasionally useful. If difficulty is experienced, he should be reminded that good soldering depends on having the articles to be joined thoroughly clean and having the soldering coppers well covered with solder before applying them to the metal. A suitable soldering paste should be applied to the articles to be soldered before they are touched by the solder itself.

The use of fabric in model construction

occurs most prominently in the wing covering. Many model makers use China silk for this purpose. Practically all notion stores carry this and it retails at about a dollar a yard. Most models require about a quarter of a yard. For the very light scientific models, thin paper is used for wing covering. This may be either Japanese tissue paper which can be purchased from Oriental shops such as Chinese and Japanese curio establishments, or rice paper may be used. Rice paper is used by draughtsmen for tracing and can be purchased from draughting supply houses.

The price for a sheet about a yard square is 15 cents. One sheet will cover about three models. Another fabric employed for covering wings is gold-beater skin. This is an animal product obtained from the lining of a cow's stomach and is very thin and light.

The usual source of power in model airplanes is rubber. This is used in unbroken lengths which have a cross section of about one-eighth by one sixty-fourth inch. This ıbber thread costs about a cent a foot. ıould some model makers prefer to use a substitute, rubber bands can be linked together like a chain to produce the desired amount of rubber. Silk thread, size A, is used for binding the parts of models together. All notion stores carry this. To prevent the hooks from cutting the rubber thread motors, many model makers use a small piece of rubber tubing over the hook. The variety used is known as spectacle tubing and is handled by opticians and rubber supply houses. An excellent substitute is obtained by using the rubber covering of small telephone wire. This may be pulled off of the electric wire and similarly placed over the model hook. A half inch length is sufficient for each hook.

Liquids in model construction are used ı two forms, namely, as adhesives and as wing coating preparations. The most suitable adhesive for model construction is .. cement known as "ambroid." This has the advantage of being water proof, quick drying, and extremely tenacious. It may be purchased from hardware stores and from stores which sell supplies for boats. nercial airplane "dope" and banana 'hich latter is sold by drug stores, are used for fastening the fabric to the wing frames. The "dope" is obtainable from ımmercial airplane supply houses.

Wing covering preparation is used particularly on silk covered wings to strengthen the fabric, make it air tight, to reduce surface friction, and to tighten it upon the frame. Colodion obtainable from the drug stores, can be substituted. A solution of strips of celluloid dissolved in banana oil makes a good wing preparation. Airplane "dope," which is used on the large machines, can be used also on models, but it should be diluted for model use. The solvent for airplane "dope" is the chemical acetone which all drug stores sell at about thirty cents a pint.

The above mentioned materials can be used to produce all airplane parts, but occasionally pieces of toys and other mechanisms are found that will lend themselves to model airplane construction. For instance, wheels for scale model airplanes can be obtained on ten-cent store toy wagons. Little ten-cent store celluloid canoes have been used successfully as floats for hydroplane models. Imitation radiators for the front of scale models can be built

(Continued on page 472)

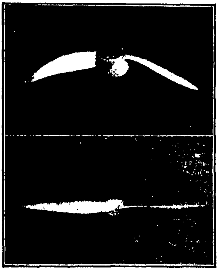
Learning To Use Our Wings

(*Continued from page* 444)

These ships constitute somewhat of a jump from accepted practice and must be considered as highly experimental.

Before and After

THE Reed one-piece duralumin propellers have participated in the securing of many airplane records and trophies. For example, the successful Schneider Cup Racers for 1923, 1925 and 1926 were all equipped with this type of propeller. It, of course, was used again in this season's Schneider Cup Race held in Venice. The metal propeller suitably designed can employ with safety an airfoil section much thinner and more efficient than that possible in a wooden propeller. Moreover, in



Top: Fairey-Reed duralumin propeller after crash. *Bottom:* The same propeller in perfect shape after it has undergone repair

case of a crash or a bad landing in which the plane noses over, the duralumin propeller can almost always be salvaged. The "before and after" photographs appended are illuminating. Here we have a Fairey-Reed propeller, bent out of working shape by a crash, assuming after repair (by simple mechanical manipulation), a perfectly mechanical and workmanlike appearance.

Noise

AT a conference of the National Advisory Committee on Aeronautics, and also at a meeting of the Royal Aeronautical Society, the question of noise was stressed as all important in commercial aircraft. We will quote the remarks of a speaker at the London session:

"I recently had the experience of flying in both the *Hampstead* and the *Argosy* (two big three-engined passenger planes used by the British Imperial Airways) and would say definitely that neither can offer the comfort one gets in an old Ford. As for the noise, I made every possible use of the cotton wool so thoughtfully provided, but that did little good . . . . . Furthermore, there is an engine attached to the nose of the machine and one on either side of the body. The one on the nose makes you aware of its presence by the vibrations it transmits to the passenger cabin, and especially if there should be any irregularities in the firing of the cylinders. . . .

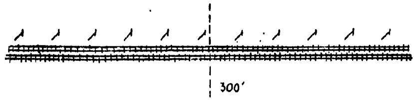


Figure 1

"In my opinion the engines should not be attached to the body, but placed on the wings . . . . . The noise is far too great with them placed as they are, and it would appear that a better position for them would be near the trailing edges of the

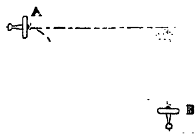


Figure 2

wings, because then the noise would be behind the passengers."

We are heartily in sympathy with these remarks. Other lines of attack in diminishing noise are, possibly: deadening the noise of exhaust by suitable mufflers; geared-down, slow running propellers, with gears which do not contribute noise (perhaps an impossibility); passenger cabins, with noise insulating material, such as cork, air-spaces, et cetera, and the mounting of the passenger cabin in relation to the rest of the machine in such a fashion that noise is not transmitted to the cabin.

Rules of the Air

THE Aeronautics Branch of the Department of Commerce has not only produced some admirable Air Traffic Rules, but in a special bulletin has shown some excellent and easily understood illustrations.

Thus in Figure I, planes must keep to the right of an airway, and when passing each other, flying in opposite direction, they must keep at least 300 feet apart.

In crossing paths, the aircraft which has the other on its right side must keep out of the way. Accordingly, as in Figure 2, *A* must keep out of *B's* way. The nearest it may approach is 300 feet from *B*. If there is sufficient space, *A* may simply follow the course AA which will bring it back of *B*, which will by that time have proceeded to *B*.

If two aircraft are approaching head-on, each must alter its course to the right, so that each may pass to the left of the other, and so that the two aircraft may be 300 feet apart, as indicated in Figure 3.

In Figure 4, *B*, which is approaching *A* at an angle of less than 70 degrees, is said to be the overtaking aircraft, and must keep clear by altering its course to the right as shown in the diagram, and *not* in the vertical plane.

A similar rule applies when overtaking slower craft.

Other rules provide for a minimum altitude of 1000 feet above a city; a minimum altitude of 500 feet when flying cross-country; no acrobatics over congested areas; no flying under 1000 feet over an open-air assemblage such as a football game.

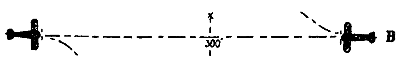
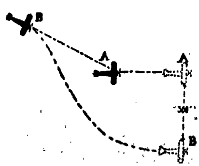


Figure 3

Landing rules are drawn up with similar logic and clarity. Thus a landing plane



has the right of way over planes moving over the ground or taking off. When landing or maneuvering in preparation for landing, the plane at the greater height must be responsible for avoiding the airplane at the lower height.

An Unparalleled Record

THE Western Air Express, operating an airline between Los Angeles and Salt Lake City has gained an enviable reputation for sound financial and operational management. Its staff of pilots is also unsurpassed. One of this staff, Captain Maurice Graham, has just made a wonder-

Wide World

Captain Graham, who has made a remarkable aviation record

ful record. In 13 months service with this company, from April 17, 1926 to May 17, 1927, he has flown 125,000 miles. During this time, Graham has never been forced down by mechanical trouble or weather conditions, has never defaulted a trip and never failed to start on scheduled time. He is to be nominated for the Clifford B. Harmon trophy given for a signal achievement in aviation.

Municipal Airports in the West

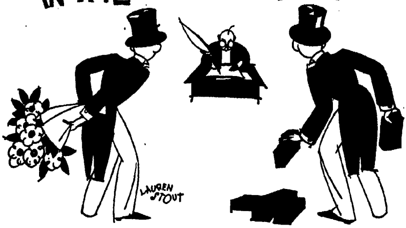
THAT the city airport should be a municipal undertaking is a widely accepted view. The expenditures involved in the construction of municipal airports are large however and the return for many years is problematical. Municipalities for many years have been none too eager to add such projects to their responsibilities. It is therefore gratifying to read that there is immense activity on the Pacific Coast.

Portland has almost completed a 1,250,000 dollar airport; San Francisco has spent nearly 100,000 dollars in improving a temporary field, and contemplates a permanent field to cost 1,000,000 dollars; Oakland has committed itself to an expenditure of 650,000 dollars; Santa Monica has spent 860,000 dollars for a site; San Diego has plans involving 800,000 dollars; and Los Angeles plans to invest 3,500,000 dollars.

We have received a typical letter from Stockton's Chamber of Commerce, boosting the municipal field with runways of 4000 feet, the ideal flying climate, and the fact that fifty airplanes visited the 177-acre field of this city at its dedication.

It is to be hoped that the city fathers of New York will follow this example.

IN THE EDITOR'S MAIL



Telescope Enthusiast Becomes More Enthusiastic

SINCE the publication, a year and a half ago, of the SCIENTIFIC AMERICAN instruction book "Amateur Telescope Making," one amateur, Mr. H. L. Rogers, a real estate broker of 10 Adelaide Street, East, Toronto, Ontario, has actually made his fourth reflecting telescope. Three of his jobs are shown in an illustration reproduced in these columns; his first was described on page 373 of the September, 1926, issue. For his enthusiasm and his evident success we take this opportunity to congratulate this enthusiastic amateur worker on his achievement. It takes some little persistence and dogged "stick-to-it-iveness" to complete four reflecting telescopes in one year. And, as his letter indicates, Mr. Rogers is not through yet—he plans to make still another telescope. Who is there among our amateurs who can come forward with a comparable record? Mr. Rogers' letter follows:

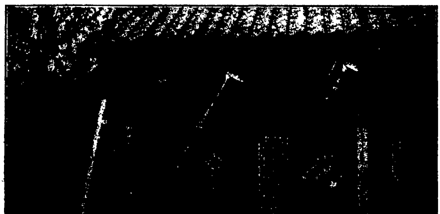
I enclose two photographs of a very successful telescope which I have made—my fourth, embodying the results of experience gained in making the first three mounts. This mount was made in about six weeks' spare time.

After making a 6-inch Springfield mount, and also a 6-inch Newtonian for a friend, I decided that I would incorporate some improvements—the result of experience—in another telescope, using the lap- of two previous 6-inch telescopes fo lum. The photogra tail to a considerable extent.

The tube is 24-gauge hard rolled brass with 1¼-inch reinforcing bands at ends and cradle. The eye-piece tube carries a helical slot and slides in an outside tube through which a pin projects, giving a nice range for focusing. The mounting is screwed to a sheet brass base let into the ... scope, giving a very rigid bearing.

You will notice a very convenient finder made of 2¼-inch brass tube with an opera-glass lens as object glass, and microscope eye-piece of about one inch equivalent focal length. Both telescope and finder have total reflecting prisms instead of silvered flats, there being a noticeable improvement on this account.

The mount is made of two ordinary brass tees with brass and iron piping for axes and bearing tubes. The stand is made of 8-inch polished brass



Three of the four reflecting telescopes built by Mr. Rogers. From left to right, his first, fourth and second instruments. All of them display careful, precise workmanship in their trim, clean-cut construction and assembly

tubing, with an aluminum piston let into each end as filling blocks. This makes an exceptionally firm and good looking mount, free from any springiness and yet light enough to be easily portable.

There is a full 360-degree slow motion on both axes. There is a plate-to-plate friction on the polar axis—the upper one fixed and the lower slow motion plate floating. These plates are held together by a split tubular washer on the end of the equatorial axis, sprung spirally, which gives an adjustable end thrust through a nut on the end of the equatorial shaft. On the declination axis friction is provided through a drum fastened to the floating slow motion plate outside of which is sprung a split 2½-inch tube, which in turn is fastened to the axis. The lead weight is cast around a ½-inch steel rod which slides in the tubular axis. The telescope tube is revolvable in its bearings. This is a very convenient feature.

Close-up, showing details of Mr. Roger's fourth telescope. The finder close to the eyepiece is ideal —no neck-twisting required here

Great care was exercised in proving the figure of the speculum. On the first test the telescope gave a wonderfully clear definition on the moon with ¼-inch eye-piece, magnification about 190. Later, however, I found that there was a slight lateral looseness of the speculum in the cell, and I installed three flat springs designed to hold the speculum central. However, it required a little pressure to press the speculum into the cell and the definition was thereby ruined, evidently straining the glass. It is now an easy fit in the cell and definition seems to be restored. I cannot emphasize too strongly the necessity

strain after this is achieved.

I must again pay tribute to your book, "Amateur Telescope Making." It is absolutely indispensable to anyone who would make a telescope. I do not think I have spent, all told, more than 35 or 40 dollars on this instrument. It has provided a very

interesting hobby and promises to be a very useful instrument.

I am still funking any further work on the projected 12-inch job, although the making of it seems less appalling after experiences gained on smaller ones. You can believe me it will be a straight Newtonian with a prism. There will be no Cassegrain or other funny stuff about it.

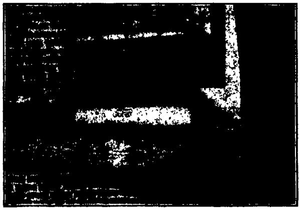
H. L. Rogers.

"Rolled Their Own"

IF you can not find the price of an airplane and want one badly enough, you can "roll your own" as a last resort. Here is a letter about a man who did just that and apparently did it successfully:

Editor, SCIENTIFIC AMERICAN:

You asked recently if any one has ever put a Ford motor in an airplane. When the writer first came to Fredonia, Kansas, in 1916, he passed a garage and machine shop on the way from the railroad station and seeing an airplane under construction inside ... ...ainted with the ... Belt, who was



A standard Ford motor that has been rebuilt for use in an airplane. A few minor alterations were made on the motor itself. In this p... shown h... block, the propeller was bolted directly to the crank-shaft. In some other models, reducing gears were employed

housed in the ... end, being closed and p... ... weather. The radiator for cooling is in the front of the fuselage

building it. He found that this was the third or fourth machine Mr. Belt had built, using Ford motors in every one of them.

The first one was an old style Curtis pusher type which Mr. Belt built from the ground up, even to the turn-buckles and propeller. The Ford engine and some Ford wheels for landing gear were the only parts he did not make himself. This machine he sold and then built others. He soon abandoned the pusher type and built tractors, of one of which I enclose a photo. This machine he sold to Paul Neff of Iola, Kansas, who flew it as high as 8000 feet, a Ford motor being the motive power also.

All the machines built by Belt have had nothing but Ford motors, although some were not directly connected to the shaft but had reducing ... machine sold to Neff w... is a photo of one of his converted Fords on a testing block to test before installing. Mr. Belt, we have good reasons to believe, is the first man in the world to fly an airplane with a Ford motor.

F. H. Marshall.
Fredonia, Kansas.

Problem

READERS who enjoy working out geometrical problems may take joy in tackling the one outlined below. Kindly send replies direct to Mr. Melhase.

Editor, SCIENTIFIC AMERICAN:

I am enclosing herewith a diag... illustrating the kite-shaped race track. As shown thereon, the track consists of two tangents each 1760 feet in length, intersecting at B and connected by a circular arc also 1760 feet long, so that the entire c... ... 5280 feet in length.

The problem in laying out this course lies in finding the angle A and the radius R, which, so far, I have been able to do only by the trial and error method.

I submit the problem in the hope that some of your readers, mathematically inclined, may be able to furnish a solution.

John Melhase,
875 Vincente Avenue.
Berkeley, California.

Jap

HERE is a short letter from a Japanese schoolboy. How many of us Yankees will volunteer to compose as good a letter in Japanese?

Editor, SCIENTIFIC AMERICAN:

Please allow me to write a letter to you to introduce. I know your name in the SCIENTIFIC AMERICAN magazine and you are a president of your office. I am a reader of your magazine, and I take this magazine before long time ago at the Department Store in Tokyo City. At once I found it very interesting, scientific magazine

in which the photograph of Scientific is very useful for me. Always I was charmed with it. This time I should like to exchange the picture post-card and postage each other of American boy and girl, but I don't know how to exchange of it each other, so I should like to beg you, will you kindly to introduce for me whom liked to exchange American boy and girl? So we will have exchange the card and other thing each other. If it was done so, how I was glad with it.

Now I am going to middle school at night course. I have one friend of American boy we met him each other at the church every Sunday and we have spend rejoicing each other.

At the end, I cannot understand so well in English. If there are any mistakes please you may give to understand.

I am,

Dear Sir

Yours very truly,

T. Mori.

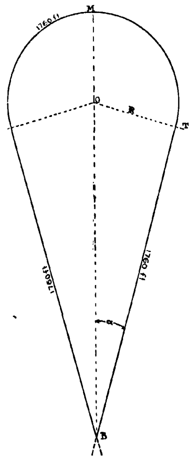
c/o The Banks of Japan, Tokyo, Japan.

To this we replied:

Dear Mr. Mori:

If we were "American boy or girl" instead of a gray-haired, hard-boiled editor we should like to exchange picture post-cards with you. Some of our younger readers will want to correspond with you, we are sure. Do not apologize for your lack of understanding of the English language. You write English far, far better than we shall ever be able to write Japanese.

The Editor.



A pretty problem in mathematics is presented by the design of a kite-shaped race track of the type shown above. The details of it are contained in a letter published on the opposite page

Applied Science for the Amateur

(Continued from page 464)

up very realistically by gluing together small pieces of soda fountain straws. Numerous other forms, such as stream-lined head rests, propeller caps, et cetera, may be formed out of "plastic wood." This is a very useful product obtainable at some hardware stores. This material is something like putty and can be molded into any form but when hard it resembles wood and can be carved or painted.

How to Make a Model Glider

DEFINITION: A glider is an aircraft which is heavier than air and has no inherent power plant.

Appearance: A glider consists of a frame and wings. Many gliders resemble ordinary airplanes without power plants but some are radical in design.

Operation: A glider is launched from an eminence and moves through the air impelled by its initial starting impulse and by the attraction of gravity. A glider coasts upon the air. In other words it combats the attraction of gravity with the support derived from its wings. Because a glider weighs more than the surrounding air it is always falling through the air, but it may encounter a rising current of air which will lift it upward, or in still air it will coast at a descending angle, moving forward many feet, while it is falling one foot. The duration of a glide depends on the initial launching elevation and velocity, the buoyancy of the surrounding air, the construction of the glider itself, and the kind of ground over which the glide is made.

Construction: Gliders are designed to move in one direction, namely, forward and slightly downward. Air conditions may cause them to depart from this position, but the glider should be inherently stable and so designed that it will regain its correct attitude, otherwise it will rapidly lose its elevation. The correct nose-down position is obtained in two ways; either by providing less lifting surface in front than in the rear, or by weighting down the nose slightly.

An elementary glider having the small wing in front can be made as follows: Procure a piece of stiff thin cardboard or wood veneer ten inches long and five inches wide. Procure also a piece of wood one quarter inch square and one foot long, two small rubber bands, and a piece of small stiff wire about two inches long. Cut from the cardboard or veneer two rectangles, one to be ten inches by two and one half inches and the other to be six inches by one and three quarter inches. These are the wings. Cut another piece two inches square and round off one corner of this to form the rudder as shown in the side view in the drawing. The same view also shows a wedge for elevating the wing. This wedge is made by cutting off one inch of the stick and cutting it in half diagonally. The wire is bent into the shape shown for the hook and is bound to the front of the stick. In the rear of the stick, a saw-cut two inches long is made and the rudder inserted and glued or nailed in that cut. The wings are slightly curved as shown in the side view and placed on the glider approximately in the positions shown in the top view. They are secured with rubber bands as shown in the detailed drawing in the right hand upper corner. This completes the glider itself.

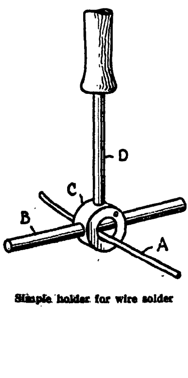
It is launched by use of a sling. To

construct this, procure a crotch from a small tree limb and to the upper ends of the crotch bind a one foot length of strip rubber, which may be obtained either by linking up rubber bands or by cutting a strip from an old inner tube. To launch the glider, hold it by the rudder in the right hand with the sling held in the left hand. By stretching the rubber and releasing the glider, it can be made to make long glides and may be adjusted to do several aerial maneuvers.

In addition to constructing an efficient glider, you must learn how to launch it properly. Even the best glider will not perform well unless properly placed in the air. You should experiment with your glider and determine the most efficient arrangement of the wings and weights. When this arrangement has been found, the placement of each part should be carefully marked in order that the glider may be always placed in the most efficient condition. The stipulations of contests with these gliders should decree that the launching must not be above six feet from the floor. Because gliders are capable of going the greatest distance forward when their original elevation is the highest, every contestant should make sure that he has the maximum elevation of six feet from which to launch his glider. If the contestant be so short that he cannot reach this elevation, he should stand on a chair or some other object. A horizontally suspended string at the exact height of six feet would be a good means of indicating the proper elevation. In launching the gliders, it will be found that they will perfrom the best when they are not thrust forward into the air but rather laid on the air with a gentle push inclining the nose slightly downward. It is remarkable what long glides can be obtained from an efficient aircraft. A reasonably good glider should be able to go forward twelve feet to every foot that it drops.

Holder for Wire Solder

A HOLDER for two thicknesses of solder, made as shown in the acc panying illustration, is a useful tool for repair shop writes H. Moore in *Machi* Many tinning and joint sweating jobs quire varying amounts of solder during the procedure of the work, and it is sometimes difficult to apply just the right amount



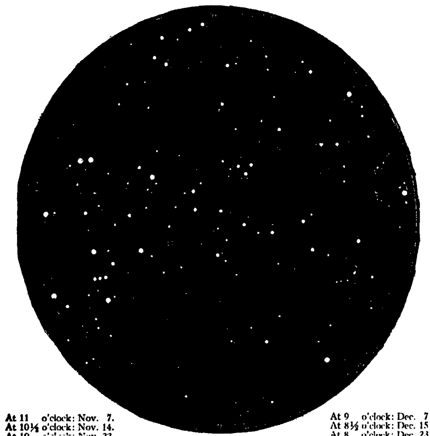
Simple holder for wire solder

less two sizes of solder are used. If a small quantity is required, the thin wire *A* is applied to the work, and if a larger quantity is needed, the thick solder at *B* is applied by turning the holder.

To make the tool shown, a collar *C* of suitable size is obtained, and a hole large enough to fit the large size solder is drilled through the collar. Then at right angles to the first hole is drilled a smaller hole which is tapped to receive the threaded end of the short rod *D*. The wooden handle is driven on a tang ground on the projecting end of rod *D*. The thick piece of solder *B* is passed through the drilled holes, and the thin piece *A* through the bore of the collar. By screwing rod *D* into the collar, both pieces of solder are secured in place.

The Heavens in November

By PROF. HENRY NORRIS RUSSELL, Ph.D.



At 11 o'clock: Nov. 7.
At 10½ o'clock: Nov. 14.
At 10 o'clock: Nov. 22.
At 9½ o'clock: November 30.
At 9 o'clock: Dec. 7
At 8½ o'clock: Dec. 15
At 8 o'clock: Dec. 23

NIGHT SKY: NOVEMBER AND DECEMBER

The Heavens

As our map shows, the finest part of the sky is in the east and southeast, where we find the Giant and Little Dogs low down, Orion and Gemini, the Twins, about them; and Taurus and Auriga higher still. Perseus and Andromeda are nearly overhead, Pegasus high in the west, Cygnus and Lyra in the northwest, Cassiopeia and Cepheus high in the north and the Bears and Draco the Dragon, below them. Eridanus and Cetus occupy the dull region in the South.

The Planets

Mercury is an evening star until the 10th, and a morning star after that date. He may be seen just before dawn toward the end of the month. Observers in the Eastern Hemisphere will have a much more interesting chance to behold him on the 10th when he transits across the sun's disk almost centrally, taking more than five hours to cross it. He enters upon the sun at 10:02 P. M. on the 9th (by Eastern Standard Time) and leaves it at 3:29 A. M. on the 10th, so that the American continent is turned away from the sun during the whole of the interesting transit.

Venus is a morning star and is at her greatest apparent distance from the sun on the 21st. At this time she rises about 2:30 A. M., and she is extremely conspicuous all through the month.

Mars is a morning star very close to the sun, and practically invisible.

Jupiter is due south at 9:00 P. M. when the month begins, and at 7:00 P. M. when it closes, and is prominent all the evening.

Saturn is an evening star visible just after dark early in the month, but lost in the twilight before its close.

Uranus is not far from Jupiter, and observable in the evening.

Neptune is in quadrature on the 22nd, and can be observed in the morning.

The moon is in her first quarter at 10:00 A. M. on the 2nd, full at 2:00 A. M. on the 9th, in her last quarter at 1:00 A. M. on the 16th, and new at 5 A. M. on the 24th. She is nearest the Earth on the 12th, and farthest off on the 21st. During the month she is in conjunction with Jupiter and Uranus on the 5th, Neptune on the 16th, Venus on the 19th, Mercury on the 22nd, Mars on the 23rd, and Saturn on the 25th.

OUR CHOICE OF RECENT BOOKS

Science: Leading and Misleading

By Arthur Lynch

A rather tart but not venomous attack, chiefly against shams in modern science. Many scientists of third and fourth rate follow the leader, blindly, like sheep. Thus there are styles in scientific thought—sometimes fads (any true scientist knows this). However, this is not one of the recent crop of bitter, provoking books written by anti-science cranks, but was written by a scientist who knows, from an inside point of view. Sweeping the whole field—mathematics, relativity, physics, chemistry, biology, psychology, medicine—he places a heavy hand on some existing sore spots and wiggles it sometimes rather ungently. Both the professional scientist (genuine) and the intelligent layman who keeps up with science and knows who the proponents of the leading theories are, will find this work of criticism well worth pondering.

E. P. Dutton & Company. $3.15 Postpaid.

General Chemistry

By T. P. McCutcheon, Prof. Inorganic Chemistry, Univ. Pennsylvania. H. Seltz, Asst. Prof. Physical Chemistry, Carnegie Institute

A treatment in two divisions. First, a concise and orderly summary of chemical facts emphasizing the natural groupings and relationships under the Periodic Law. Second, the essentials of theoretical chemistry each complete and free from irrelevant matter.

D. Van Nostrand Co. $3.65 Postpaid.

Acetate Silk and Its Dyes

By C. E. Mullin

Of special interest to all users of cellulose acetate and acetate silk as well as dyestuffs and dyeing. This latter portion of the book deals with several classes of dyestuffs which hardly receive mention in any other book in any language. Patent abstracts give invaluable aid to the research worker, along the lines of the rayons or dyestuffs.

D. Van Nostrand Co. $6.20 Postpaid.

Modern Electrical Illumination

By C. Sylvester, T. E. Ritchie

A complete treatise on almost every form of commercial, industrial and social illumination. Lighting designs and examples of good and bad systems are shown with advice as to why and how certain methods will give superior results. Abundantly illustrated. A splendid example of meritorious book-work.

Longmans Green & Company. $15.00 Postpaid.

History of the Explosive Industry

By A. P. Van Gelder, H. Schlatter

This is not a text-book of manufacture, though technical development is treated somewhat in detail, it is a running narrative obtained through interviews and correspondence, research in colonial archives and those of the powder companies and a digest of the most important credited data that can be obtained. A much needed and important contribution.

Columbia University Press. $10.52 Postpaid.

Modern Automobile Painting

By M. J. Pearce

The literature on this subject is very meagre indeed. More progress has been made in automobile painting in the last few years than during any similar period in the industry. This book will therefore be a most helpful guide to anyone interested in motor car finishes.

David McKay Company. $3.15 Postpaid.

Statesman's Year Book

M. Epstein, Editor

The sixty-fourth issue of this compendium of statistics for all the countries of the world. Invaluable as a reference wherever accuracy of fact is of first importance, as the revisions have included the latest details with regard to political divisions and data?

The Macmillan Company. $7.70 Postpaid.

Commercial Property News

A Department of Facts and Notes of Interest to Patentees and Owners of Trademark Rights

CONDUCTED BY MILTON WRIGHT

The Stillson Wrench Case

"IF ; isn't an Eastman it isn't a kodak." No manufacturer save Chesebrough may use the term "vaseline" for his petroleum jelly. None but the Celluloid Company may call its product "celluloid." Anybody, however, may now make wrenches and call them "Stillson."

Although the Walworth Company is the originial manufacturer of the famous Stillson wrenches, although it is the only manufacturer ever authorized by Daniel Stillson, the inventor, although it has manufactured wrenches called Stillson constantly since 1869, under the trademark "Stillson," and although its trademark has been registered in the Patent Office for the last 21 years, the United States Circuit Court of Appeals for the First Circuit proclaims the word not properly registrable and cancels the Walworth's registration on the ground that it was obtained in 1906 by misrepresentation and fraud.

The decision affirms the lower court's decision in the suit for infringement brought by the Walworth Company against the Moore Drop Forging Company. Among other things the court says:

"In October, 1904, the defendant began the manufacture of the Stillson wrench on a large scale. Over 1000 such wrenches were shipped prior to February 15, 1905, m· ·ked 'Stillson Wrench Made by Moore D· ·p Forging Company, Springfield, Mass., U. S. A.' Defendant continued its business uninterruptedly and without protest from the plaintiff until this suit was filed (without prior notice to the defendant) on May 5, 1925. Evidence indicates that the defendant has manufactured and sold 5,000,000 of such Stillson wrenches during this period of about 21 years, involving a business of about 4,000,000 dollars.

"The court below, in an oral opinion, delivered apparently at the close of the trial, held that Stillson as applied to the wrench when the plaintiff began to manufacture it under the Stillson patent was purely a descriptive word indicating the construction of the wrench; that, while the registration was *prima facie* evidence that the word had attained a secondary meaning as indicating a wrench made by the plaintiff, it was still a question of fact as to whether the *prima facie* case made by registration was overthrown by the other evidence in the case. The court held that it was 'so overthrown,' and that, on all the evidence, the word Stillson was never used by the plaintiff as a trademark. That court also held that even if there were a trademark, the defendant had not infringed as the evidence showed that all the wrenches put out by the defendant were marked 'Stillson Wrench Made by Moore Drop Forging Company.'

"The court below found, on all the evidence, that the plaintiff was not the exclusive user of the word Stillson as applied to wrenches at the time when it applied for the trademark upon which this suit is based, and that on this additional ground the registration was fraudulently obtained by the plaintiff; he, therefore, sustained the counter-claim; dismissed the bill with costs; and referred the case to a special master to state the damages (which he finds to be substantial) suffered by the defendant by reason of the fraudulently obtained registration.

"It is too plain for argument that these findings are fully supported by evidence, practically uncontradicted and unmodified."

Claims May Be Too Broad

SOMETIMES an inventor will claim too much under his patent. In such a case, should there be litigation, the courts have two alternatives: to limit the claims to a narrow interpretation, or to recognize the wide scope of the claims and hold them invalid for lack of invention.

The suit brought recently by the Richardson Company and James C. Woodley against the Hood Rubber Company is a case in point. The plaintiffs complained of the manufacture by the defendant of boxes for storage batteries to be used with automobiles. These were made of a bituminous compound consisting of asphalt, asbestos and a kind of cotton waste, and were molded while the composition was in a plastic state. The patent in suit was for a "fibrous composition and process of manufacture" especially applicable to roofing.

The inventor described his patent as follows:

"I have described my product with particular reference to making roofing sheets in rolls, but it may be produced in the form of shingles, flat sheets, tiles, et cetera. Also, on account of the superior strength, insulating and wearing properties of my composition, I may employ it advantageously in other arts, as for example, in making paving blocks, floor tiles,

Patents Recently Issued

Classified Advertising

Advertisements in this sect insertion; minimum number of pany each insertion.

Official copies of any patents listed in this section at 15c each; state patent number to insure receipt of desired patent copy.

Pertaining to Aeronautics

AIRPLANE CONSTRUCTION—In which a relatively small propeller is used as an auxiliary directly in front of the inactive area of the regularly used, larger propeller, thus increasing speed. Patent 1637398. M. Syracusa, 1641 So. California Ave., Chicago, Ill.

Pertaining to Apparel

HOSE SUPPORTER—An elastic member which will act to tighten the top of the hose against the leg and thereby produce a supporting action. Patent 1637948. S. Kurzer, 23 Fulton Ave., Middle Village, N. Y.

UNION SUIT—Formed of woven substantially non-elastic fabric, an elastic waist band formed of knitted fabric, with the upper body portion and neither portion connected thereto. Patent 1638592. H. F. Monheimer, c/o Munn, Anderson & Munn, 24 West 40th St., New York, N. Y.

MOLDED-FLANGE INSOLE—Producing an upstanding flange substantially at the insole periphery, for the purpose of making room for the stapling anvil of a lasting machine. Patent 1638705. A. H. Prenzel, Halifax, Pa.

HEADDRESS—Having novel means for adjusting the head encircling parts, and so constructed that distinctive ornaments may be worn in combination with the headdress. Patent 1638-756. H. Wallman, 66 Franconia Ave., Flushing, N. Y.

Chemical Processes

MINERAL FEED AND PROCESS OF PREPARING THE SAME—A mineral feed for domestic animals, which does not dry out, consisting of the following ingredients, treated rock phosphate, limestone, salt cake, charcoal, common salt and water. Patent 1637428. V. R. Rupp, c/o Moorman Experiment Station, Moorman Mfg. Co., Quincy, Ill.

DESIGN FOR AN ORNAMENT FOR RADIATOR CAPS—Patent 72934. A. Cheron-Duval, 6424 Yucca St., Los Angeles, Calif.

DESIGN FOR A WOVEN FABRIC OR SIMILAR ARTICLE—Patent 73022. L. Gluhm, % Phoenix Mfg. Co., 40 Thomas St., New York, N. Y.

DESIGN FOR A FINGER RING—Patent 73107. M. E. Soman, % D. A. Walters, 2 W. 45th St., New York, N. Y.

DESIGN FOR A GAME BOARD—Patent 73108. W. Rowe, 511 W. 60th St., Chicago, Ill.

DESIGN FOR A DRESS.—Patent 72923. J. C. Worth, c/o David Crystal Inc., 1351 Broadway, New York, N. Y.

DESIGN FOR A CURTAIN-POLE—Patent 73131. W. F. Hofmann, % H. L. Judd Co., 87 Chambers St., New York, N. Y.

DESIGN FOR A CURTAIN CRANE—The inventor has been granted two patents for ornamental

floor coverings, storage battery containers, pipes or conduits, electric insulating, et cetera. I may also, if desired, incorporate with my material coloring matter or mineral or other filler."

Commenting on this, Judge Lowell of the Massachusetts Federal District Court, says:

"This is merely the expression of the patentee's day-dream—an inventor's 'castle in Spain.'"

The court contrasts the roofing and the battery box and dismisses the complaint, saying:

"After a careful consideration of the terms of the specification I have come to the conclusion that the claims do not cover the process of manufacture of a firm, acid-resistant battery box such as the defendant makes. This result is safer for the plaintiffs, as it saves them from the danger of having their patent, if it were more broadly interpreted, declared invaild for lack of invention."

Hokum Patents

"HOKUM—a word, act, business or property used by an actor to win an audience."—"The Desk Standard Dictionary."

A song is not getting across the footlights very well; the audience is apathetic. In the last stanza the singer waves the American flag. The audience cheers and the act is a success, or, as they say on Broadway, a "wow." That flag-waving is *hokum*.

There is, of course, plenty of hokum in business, too. Sometimes a patent is the "word, act, business or property used to win an audience," or prospective purchaser. For example:

The writer recently was chatting with the president of a company engaged in construction work in which patented products are installed. His chief competitor is one of the biggest organizations of manufacturing engineers in the country.

"The big fellows are making it mighty hard for us," said our friend.

"How come?" we asked, using a current slang phrase.

"Well, they have a patent. Scientifically it is worse than useless, but from a business standpoint it is a winner. Our unpatented product is better than theirs; our price is lower; our service is as good or better; but that patent has us stopped."

"Why?"

"That company deliberately will change a product for the worse for the sake of getting a patent. They will make changes and innovations that they know—and their engineers are among the best in the United States—are not in the line of improvement, just so they can have a monopoly in something. Never mind how much merit the invention has or has not."

"But what good does the patent do them?"

"It is a sales argument. They flaunt that patent before a prospective customer and he thinks there must be some special merit in the product if they are so proud of it. Perhaps the prospective customer says, 'But your competitor says his unpatented product is better than your patented one.' They come right back at him with, 'Of course, he claims that. But he couldn't use a product like ours if he wanted to, could he? We are the only people who can give you this patented product.'

designs for certain cranes. Patents 73165; 73166. A. Diouhy, c/o H. L. Judd Co., 87 Chamber St., New York, N. Y.

DESIGN FOR A CURTAIN-POLE END—The inventor has been granted three patents for ornamental designs. Patents 73178, 73179 and 73180. W. F. Hofmann, c/o H. L. Judd, 87 Chamber St., New York, N. Y.

Electrical Devices

RADIO TUNING DEVICE—In which the dielectric losses are reduced to a minimum, the distributed capacity low, and the eddy current losses considerably reduced. Patent 1687928. H. F. Venske, Boyertown, Pa.

INDUCTANCE—In which the winding is so arranged as to minimize the effective electromagnetic field, whereby two or more inductances may be placed in close proximity. Patent 1687649. S. Kurka, 1636 So. Harding Ave., Chicago, Ill.

LAMP-SOCKET CONSTRUCTION—A resilient mounting, particularly adapted for Christmas tree lamps, whereby when the filament of any one of a plurality of lamps is broken, it can be quickly discovered. Patent 1638691. L. A. Hofstetter, 22 46th St., Union City, N. J.

SHIELD FOR USE IN THE PRODUCTION OF RADIOSCOPES OR RADIOGRAPHS—Comprising a circular frame, strip-shaped blades of X ray opaque material mounted therein, and having one fixed to the frame, the other free to vibrate. Patent 1688688. M. Demarchi, c/o G. Capuccio, Via Arsenale N. 17, Turin, Italy.

Of Interest to Farmers

ORCHARD HEATER—Of simple construction, adapted for the use of a liquid hydro-carbon and having means for partially vaporizing the fuel and for carbureting the fuel vapors. Patent 1687983. J. C. Beckley, c/o Am. Welding & Tank Co., Tampa, Fla.

HOG WATER FOUNTAIN—For use in hog pens, there being an arrangement of pans to hold mud, and valves to prevent the mud from entering the float chamber. Patent 1687940. M. J. Hoech, Randolph, Neb.

Of General Interest

COMBINATION CIGARETTE OR CIGAR AND MATCH—The combination being in such manner that the match may be easily disassociated without injury to the cigar or cigarette, and ready for lighting. Patent 1685967. F. Stone, Rosalia, Wash.

SAFETY DEPOSIT RECEPTACLE—A portable receptacle by means of which a traveler in a public conveyance, such as a train or boat, may protect his valuables against theft. Patent 1684884. E. S. Peer, P. O. Box 1367, Station "C" Los Angeles, Calif.

TEMPORARY BINDER—Capable of securely holding magazines, catalogues and similar publications, of various forms of binding, such as center or side wire stitched, or sewed. Patent 1683070. F. H. Crump, 225 E. 4th St., Los Angeles, Cal.

COMPACT EJECTOR FOR VANITY CASES—Wherein a swinging bar extends normally across the bottom of the vanity case and acts to swing the compact carrying plate out of the case. Patent 1685891. W. G. Kendall, 118 Market St., Newark, N. J.

REINFORCED AIR HOSE—Such as is used in mine ventilation, having continuous external flexible suspension flange, with connecting strips secured to the tube. Patent 1685957. A. S. Richardson, 1288 W. Granite St., Butte, Mont.

BERRY BOX—Which may be formed from wood, card-board or similar material from one piece folded to make the complete box. Patent 1686806. H. F. Keller, Jr., Longmont, Colo.

"Now what comeback have we in a case like that? We can argue until the cows come home and it will do no good. The patent has us licked."

All of which goes to illustrate the truth that where something has its uses it has its abuses, too, and that patents have features that Thomas Jefferson probably

While a Reissue Patent Is Pending

A MAN patents an invention, and after obtaining his patent discovers it is advisable to apply for a reissue of the patent. Before he gets his reissued patent, however, another man infringes the claims of the pending reissued patent, but not of the original patent. Can the patentee recover damages?

Such was an issue in the recent case of the Bull Dog Floor Clip Company against the Munson Manufacturing Company before the Circuit Court of Appeals for the Eighth Circuit. The patent covered a metal device for use in holding flooring sleepers in place on a concrete base. Says the court:

"The evidence shows without dispute that after reissue of the Prickett patent, defendant sold 150,000 of the clips, Exhibit 16, which I have held to infringe claims 4 and 5 of the reissue patent, but not to infringe the original patent.

"The evidence shows that all of these clips were made by defendant during the summer of 1922 and nearly two years befor the reissue was granted, and were sold after the reissue of the Prickett patent.

"It also shows that defendant applied to its attorney for an opinion as to the coverage of the Prickett patent and was advised that it did not cover the clip Exhibit 16. Apparently Cole was willing to rely upon the advice of his attorney, and, as the conclusion reached by the special master is that the clip Exhibit 16 did not infringe the original Prickett patent, it must be held that defendant had the right to dispose of the 150,000 old clips remaining on hand after the reissue."

Patents for Useful Designs

CAN a man get a design patent on an invention made primarily for purposes of utility rather than invention? The Primary Examiner thought not, and therefore refused a design patent to Alphonse F. Pieper on a universal joint. The Examiners-in-Chief thought differently, however, and reversed the decision, saying:

"It does not necessarily follow that because an article may serve a utilitarian purpose it cannot be ornamental. In the design of the instant application we find evidence that the universal joint shown was given its particular shape because of a desire to secure an ornamental appearance. Appellant states in his brief that the joint disclosed is primarily intended for use in association with apparatus employed in dental parlors where an appeal to the esthetic sense is desirable. That appellant's design is ornamental is evident, we think, on comparison with the universal joint of the mechanical patent to Wilkinson. As a mechanical structure, appellant's device is probably no better than that of the patent, but so far as ornamental appearance is concerned there is no doubt as to which is the more desirable."

CORNICE BLOCK—Designed for strengthening and holding hollow terra cotta, or artificial stone cornice-forming blocks, when first assembled and after they have been set. Patent 1635898. J. Lynch, 619 Carson Ave., Perth Amboy, N. J.

WALL BOARD—A composition board, for use in facing walls, so constructed that when a plurality _e used the seams will be effectively concealed. Patent 1635922. P. T. Beygrau, 1049 Keith re., Berkeley, Calif.

VANITY-CASE HINGE—In which practically all of the parts are arranged interiorly of the casing, so that the exterior is left smooth and even. Patent 1635941. W. G. Kendall, 118 Market St., Newark, N. J.

CREEL CARRIER—Adapted to be supported either on the back or at the side of the wearer and carried comfortably, adjustable to various sized wearers. Patent 1635928. W. R. Davis, Wallace, Idaho.

UNIVERSAL JOINT—Which will enable the utmost relative flexibility and a wide range of variation in the position the parts can assume, as the elements are manipulated. Patent 1635164. N. W. Amdur, % Sun Ray Lighting Products Co., 119 Lafayette St., New York, N.Y.

SYSTEM OF TAKING PHOTOGRAPHIC AND CINEMATOGRAPHIC PICTURES—In composite form, by which objects of different scale are united within the camera by means of a mirror or series of mirrors. Patent 1636112. E. Schufftan, Kaiser Allee 79a, Berlin, Friedman, Germany.

LOAD BINDER—Which will permit of instantaneous locking of the binder and equally quick taking up of the slack cable, yet the lever may be easily opened by hand. Patent 1636638. F. A. Jenkins, Box 115, Older, Texas.

BUNG-PLUG LOCK—For bung plugs of steel drums, to prevent theft when they are ungarded on loading platforms, in the fields, or other places. Patent 1636641. B. F. Lewis, % Olga Garage, Olga, Fla.

of a large number in a freight car on in storage

damaged. Patent 1636607. J. S. Horton, Laurel Del.

SHINGLE—Of the lock-down type, which may be cut from a roll of roofing paper, insured against curling, and secured by a single nail. Patent 1637306. J. E. Hooker, Box 475, Coral Gables, Fla.

HAT BOX—Arranged to carry ladies' hat as well as other articles of clothing without damage to the hat or other articles. Patent 1637223. J. A. Holtzman, 215 W. Baltimore St., Baltimore, Md.

CABLE GUARD—For supporting a cable on a post, wherein an adjustable bracket is used to support the cable in spaced relation and at proper tension to the post. Patent 1637241. L. E. Quist, Warren, Minn.

PAN LIFTER—Which can be easily placed in engagement with, or disengagement from a hot pan, for lifting the same without injury or discomfort. Patent 1637227. A. R. McDaniel. Johnstown, Neb.

METHOD OF PRODUCING THE SHELLS OF METAL BOXES—From sheet metal, and incorporating an ornamental design, without distorting the members of the blank, as employed in the production of vanity cases. Patent 1637242. A. F. Reilly, % Evans Case Co., No. Attleboro, Mass.

CROSS-JOINTED METAL BAR—Wherein part of one bar is cut and pressed into a bracing of the other bar, none of the metal being removed, for use with metal window sashes. Patent 1637220. S. J. Gary, 3242 De Catur Ave., Bronx, N. Y.

FLOORING TILE—Which will be free from pot marks, have a hard surface which will not allow dirt to be readily ground in, may be easily washed, will hold its original color and will have maximum strength and wearing qualities. The inventors have been granted two patents 1637301 and 1637302. G. C. Hannam and J. W. Schede, 1 Madison Ave., New York, N. Y.

METHOD OF MAKING IMITATION MARBLE—Which comprises forming a mold with a glass bottom, coating the glass with colors to produce veining and pouring in a body layer of conci ing mixture. Patent 1637946. K. R. Knofe, address Trygve Mamen, c/o Carl Fisher, Port Washington, N. Y.

PROTRACTOR—For plotting and measuring angles, whereby the scale of graduations is doubled so that the readings are caused to be much more accurate. Patent 1637933. C. B. Galvin, 448 Central Park West, New York, N.Y.

COMBINED HAND MIRROR AND TABLE MIRROR—In which the handle portion may be rigidly coupled to the frame to define a handle, or locked in folded position to constitute an easel. Patent 1638672. J. J. Walsh, 246 N. Broadway, Yonkers, N. Y.

INSECT CATCHER—Which may be used for catching insects alive without crushing them, as with a fly swatter, and for trapping them until desired to remove them. Patent 1638690. C. Y. Hake, 1450 Mt. Rose Ave., York, Pa.

REFRIGERATOR AND DISPENSER—For holding a plurality of bottles in position to be affected by a refrigerant, and so that they may be removed without outside air gaining entrance. Patent 1638181. G. C. Bell, 1219 Hichman Rd., Augusta, Ga.

SKYLIGHT—Which has a metalic frame and is of fire-proof construction, and in which the respective members brace one another forming a durable structure. Patent 1638668. S. Volk, 122 Water St., Benton Harbor, Mich.

FASTENING DEVICE—Especially adapted for use in connection with loose leaf-binders, also adapted for use as a fastener for papers, the parts being held against displacement. Patent 1638763. G. H. Ennis, 1812 Harrison Ave., New York, N. Y.

around the neck, may be unfolded and displayed as a cross, or folded t

Patent 1638743. G. W. Peterson and B. T. Walls, c/o B. T. Walls, 1210 E. 16th St., Long Beach, Calif.

UMBRELLA COVER, RIB AND STICK CONNECTION—And means for readily associating the elements specified so that they may act as an emergency water protection means. Patent 1638764. F. Fabbrin, c/o Continental Products Corp., Att. J. W. Miller, 165 Broadway, New York, N. Y.

TRANSPLANTING DEVICE—Designed for use in removing plants from pots to the ground without injury to the roots, the earth surrounding the roots remaining in compact form. Patent 1638693. B. Hooks, Thomas, Okla.

ANIMAL TRAP—Especially for catching mice and rats, the trap cannot be robbed without the animals being caught, there is no trigger mechanism to get out of order. Patent 1638767. W. L. Harmon, Langley, Wash.

DRY FIRE EXTINGUISHER—In which an extinguishing powder is driven in the form of a jet from a receptacle by means of gas under pressure. Patent 1638729. W. Friedrich, Guericke Str. 21, Jotelhaus, Berlin, Charlottenburg, Germany.

PAVING BLOCK—Comprising a metal plate having upon its under side downwardly extending lugs and anchorage members, for forming traffic control lines in roadways. Patent 1638744. T. J. Priestman, c/o H. J. C. Forrester, Jessel Chambers, 88 Chancery Lane, London, W. C. England.

Hardware and Tools

CAN OPENER—That may be used with safety for cutting the end of a can without liability of the cut edge inflicting injury to the hands. Patent 1636785. A. W. Peterson, 1533 E. 74th St., Chicago, Ill.

BOILER TOOL—An attachment for power-driven rotary device which will function to screw a socket into a boiler sheet without exerting any pressure with the end of the socket member. Patent 1637949. H. A. Lacerda, 330 1st Ave., Watervliet, N. Y.

Machines and Mechanical Devices

PASTER CUTTING AND APPLYING MACHINE—For adhesive tape, wherein the tape is automatically fed and the surface moistened and the tape cut and pressed almost simultaneously. Patent 1636811. F. T. McGlynn, 110-36 177th St., Jamaica, L. I., N. Y.

HAND DEVICE FOR CUTTING AND POLISHING DIAMONDS—Which can be operated by unskilled labor and is so constructed that the operator is positive that the diamond will not be overground. Patent 1636671. A. Anzelewitz, 27 Rue Queltin, Antwerp, Belgium.

ADDRESSING MACHINE—Which allows addresses to be easily printed by the use of thin stencils made by a typewriting machine. Patent 1637938. E. Heuze-Beauregard, c/o Office Picard, 97 Rue St. Lazare, Paris, France.

SEPARATOR—Particularly useful in the recovery of natural gasoline from natural gas, by mechanically producing foam, and thereby increasing surface contact between the oil and gas. Patent 1637947. M. H. Kotzebue, 1526 So. Victor St., Tulsa, Okla.

WELL SCREEN—Having a spring screen body made up of a plurality of convolutions, which may be readily adjusted to afford a trap for fine sand. Patent 1638731. H. E. Hanson, Nevis, Minn.

TORPEDO HOOK—Which will prevent premature explosions in lowering torpedos or explosive shells into oil wells, and permit the release at the proper point, in "shooting" the well. Patent 1638678. O. Bond, Sapulpa, Okla.

Prime Movers and Their Accessories

STEAM BOILER—Having novel means for feeding water to the vaporizer elements in such manner as to insure the equilization of steam pressure within all parts of the device. Patent 1637929. C. J. Carlson and O. M. Elton, Lexington Aptmt., Helena, Mont.

INTERNAL-COMBUSTION ENGINE—Of simple and durable construction, utilizing all the energy in the fuel to produce maximum power, highly flexible in operation, and minimizes vibration. Patent 1637958. F. N. Newson, 245 Garfield Ave., Salt Lake City, Utah.

Pertaining to Recreation

TALLY—Or indicator for use in the playing of games, such as dominoes, with means for preventing the headed pins from being completely removed, although readily shifted. Patent 1637211. B. B. Bley, 1009 So. 15th St., Waco, Texas.

GAME BOARD—Of the type used in playing checkers or chess, affording a clear playing surface, yet providing pockets for releasably, holding the counters or men. Patent 1637922. F. A. Sullivan, 609 W. Market St., Bethlehem, Pa.

BOWLING PIN—A method of reconstructing an old and worn pin to precisely the same dimensions as in its original state, thereby effecting economy. Patent 1635472. G. P. Geiser. 3953 Janssen Ave., Chicago, Ill.

TOY PUMP—Wherein a spring motor and other parts of the structure are securely held in position, so that they will withstand hard usage. Patent 1635978. J. A. Ross. 147 Prospect St., Nanticoke, Pa.

DIVING BOARD—In which that portion of the board behind the fulcrum flexes so as to lend a higher degree of resilience without undue strain

(Continued on page 480)

Patent [illegible] W. E. Brown, 106 Nevada [illegible]

AMUSEMENT DEVICE—Consisting of a target at which balls are adapted to be manually thrown, a padded support functioning to minimize the scattered fragments of the broken targets. Patent 1684645. I Noda Broadway cor West 15th St., Coney Island, N Y

FIGURE TOY—Simulating a human being swinging a golf club as in the act of putting success depends largely upon skill in manipulating the toy Patent 1686042. F E Buckberg 5617 Indiana Ave. Chicago Ill

Pertaining to Vehicles

AUTOMOBILE JACK—Capable of quick and easy attachment to the rim of a wheel and when attached will cause elevation from the ground upon the wheel being rotated. Patent 1684391 J T Amiss Triad Bldg Baton Rouge La

AUTOMOBILE LOCK—For locking the steering post of an automobile against turning and simultaneously to break certain important electrical circuits, for example the ignition lighting and horn circuits. The inventors have been granted two patents of a similar nature Patents 1685079 and 1685080 V L Gilpin and C R. Wells 8058 Dupont Bldg Coincidental Lock Co Wilmington Del

SAND BAG—Adapted for use within and conforming to the interior of a tire or shoe to hold the same in shape when under pressure during the vulcanizing process Patent 1635094 E Nestler % Nestler Rubber Fusing Co 245 W 55 St. New York N Y

CIRCUIT-CONTROLLING APPARATUS—Adapted for use in controlling the bright and dim lamps of head lights, and maintaining control of the steering wheel during such operation Patent 1625832 M A. Stein % Mays & Rouse 1720 Llewellyn Ave Norfolk Va

STEAM GENERATOR—For steam automobiles the generator being made up of a plurality units each receiving a small volume of water and being automatically cut-off should they burn out or break Patent 1684604 H S Anderson % Santa Fe R. R Phoenix, Arizona

ANIMATED WIND-OPERATED ORNAMENT—Adapted for use on radiator caps the device represents ornamental figures, to which the wind imparts movement and includes a supporting bracket Patent 1635937 S Grillo and J Guerra 8890 Lake Ave Tuckahoe N Y

VEHICLE LEVELING DEVICE—Particularly useful in connection with cotton picking machines to permit of adjustment of the main frame in picking from high and low plants. Patent 1636620 H N Berry % H A Gamble Greasley Bldg Greenville Miss.

GARAGE—In which a maximum number of cars may be stored in a minimum of space and handled with ease when moving into or out of the garage Patent 1686600 E Geiger 121 Washington Ave Irvington N J

TENSOR SYSTEM—Which can be rapidly put into action of producing a powerful tension to the lateral chains of a non-skid outfit as applied to tires. Patent 1636633 A. G Hartung, % G Breuer Maipu 671 Buenos Aires Argentina

CLUTCH PROTECTING DEVICE—In the nature of a foot pedal adapted to sustain the pressure of the foot against movement when resting inactive upon the clutch pedal Patent 1636959 [illegible] M Hibbets Claude Texas

[illegible] TRANSMISSION—Designed as a substitute for the gear shift and clutch mechanism, can be controlled by a foot pedal to vary the speeds [illegible] to low Patent 1637968 M D [illegible] Rogers St. Brooklyn N Y

[illegible]—A repair element for the vulcanization [illegible] for tires comprising a metal cup a [illegible] a combustible composition and [illegible]. Patent 1637931 P F M.A. [illegible] G Chassevent, 11 Blvd de [illegible]

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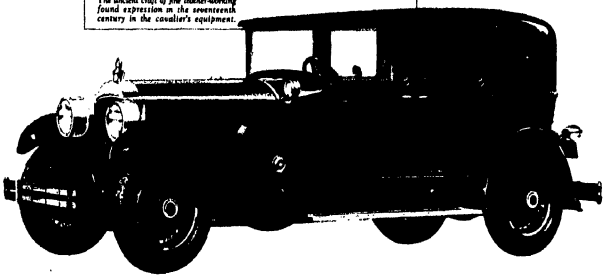
The ancient craft of fine leather-working found expression in the seventeenth century in the cavalier's equipment.



IN leather selection and upholstery work Packard standards are as high and exacting as in the precision manufacture of motor parts.

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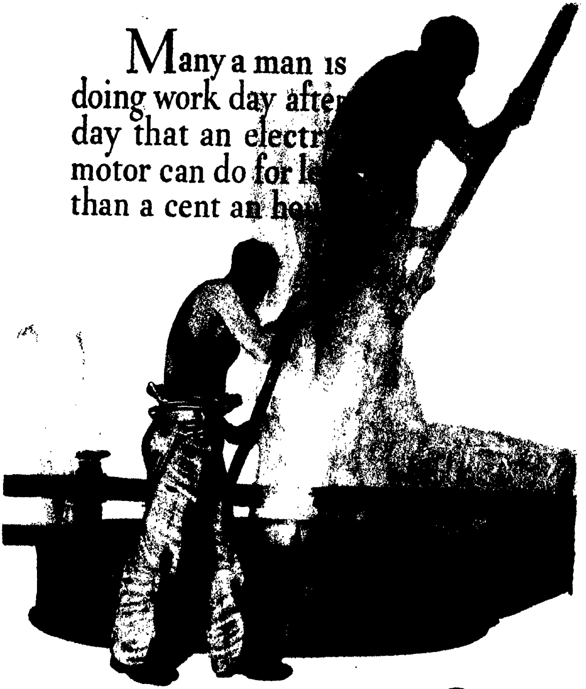
ASK THE MAN WHO OWNS ONE

Many a man is doing work day afte day that an electr motor can do for l than a cent an h



ASK your electrical expert to help you select the labor-saving electric equipment best suited for your factory, farm, or home.

Guided by human intelligence, electricity can do almost any job a man can do. From stirring to grinding, from lifting to pulling, you will find a G-E motor specially adapted to any task.

GENERAL ELECTRIC

SCIENTIFIC AMERICAN

DECEMBER 1927 *Thirty-five Cents a Copy*

PRE-SUMERIAN MAN

BY L. H. DUDLEY BUXTON

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LIFE-SAVING AIRPLANES

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YOU may not be interested in spindles beyond giving a thought to them as one of the things that plays a part in your daily life. But, you *are* interested in economies made possible by this newest application of anti-friction principles.

By reducing friction within the spindle almost to the vanishing point, the SKF Roller Bearing Spindle has resulted in power savings of from 25% to 35% per frame. And, instead of oiling every other week, as is necessary where the old-type plain bearing spindle is used, the SKF Roller Bearing Spindle requires oiling only once a year.

Perhaps you, too, have a friction problem that increases *your* production costs. Why not put it up to Anti-Friction Headquarters and place the engineering experience and laboratory facilities of the SKF world-wide organization behind it?

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OF INTEREST ONLY TO TEXTILE MANUFACTURERS
The SKF Roller Bearing Spindle Bolster was perfected by SKF engineers about six years ago. Since that time it has been going through its baptism of tests in SKF laboratories and under actual mill conditions. It has not only shown decided savings in operating costs, but it has made possible a more uniform twist and, in general, a better yarn. SKF Industries, Incorporated, makes only the roller bearing bolster. The complete spindle equipped with this bolster may be secured through all manufacturers of cotton spinning machinery in this country.

Ball Bearings SKF ... the Bearing ... the ... Place Roller Bearings

SCIENTIFIC AMERICAN

December 1927 — *Edited by* ORSON D. MUNN — Eighty-third Year

Ultra-Violet

MOST people now understand the health value of the ultra-violet (U-V) ray. There are two sources of this ray for treatment—special lamps and the sun. The lamps should be used by specialists, is the pronouncement of the Council on Physical Therapy of the American Medical Association. The sun is different, and within limitations understood by nearly everyone, can seldom do harm. This is because the short wavelengths emitted by lamps, injurious unless employed with understanding, are all safely filtered out of the sunlight by the atmosphere.

The best way to get the U-V of sunlight is to get out of doors into the sunshine—although there is comparatively little U-V in it in winter, especially in smoky cities, except at midday.

Just now the public is becoming interested in various glass substitutes which, unlike common glass, will permit the vital range of the U-V wavelengths to enter the home. Most of these substitutes do let in much of the vital portion of the total U-V, but, as might have been expected, imitations sold under plausible but utterly misleading advertising have recently been put on the market. Here is the nubbin of the argument: These imitations do admit the U-V, but it is not the vital range of the U-V, but the range lying on the spectrum between the vital range and visible light.

Before investing, investigate.

Mississippi

DOES the Mississippi River flow uphill? This question, with which one bright boy in nearly every geography class tries to stump the teacher, has been asked so often of the Geological Survey of the Department of the Interior, that its Director, G. O. Smith, has issued an official, formal explanation.

"The question which arises so frequently is based on the idea that 'up' is away from the center of the earth and 'down' is towards it," he says. "If these were the only meanings of the words, then it might be said that the Mississippi River flows uphill, for the polar radius of the earth is over 13 miles shorter than the equatorial radius and as the Mississippi River extends over 18 degrees of latitude, its proper proportion of this difference amounts to more than four miles, the river's source being much nearer the center of the earth than its mouth.

"Motion 'up' and 'down,' properly defined, refers to movements against the attraction of gravity or to those acting with it. Water acted upon by gravity alone flows downhill and the Mississippi River, which rises at a point about 1500 feet above the level of the sea, is not an exception to the rule."

Babies

EVER since King Solomon made his decision in the famous case of Wife [illegible] versus Wife [illegible], the question of identifying children with their true parents has been arising. Hospitals have done the best they can, sometimes marking the infant with a silver nitrate pencil, sometimes by footprints or fingerprints, sometimes by bead necklaces spelling out the infant's name. None of these methods, however, is fool proof, no matter how quickly the identifying mark is affixed. Nurses and doctors are but human, and it is human to err.

"This is not my baby!" cries a mother in a hospital when a little bundle of red humanity is brought to her. Records are shown to her; they bear erasures, and she is unconvinced. She cannot prove the child is not hers, the hospital cannot prove it is. Here is a problem for the scientists, if ever there was one. But the scientists throw up their hands; establishing parentage with certainty is something science has not yet learned to do. Here is a gap in our knowledge of the ways of nature. It is a gap that should be closed, and who can say that the closing of it will not add more to the peace of mind of our womenfolk than all the airplanes that ever could wing their way across the Atlantic?

Cover

ON page 508 of this issue will be found a collection of interesting photographs of the latest types of battle tanks used by the British army. For our cover illustration we have used a painting of one of these tanks equipped with radio apparatus for communication with airplanes and with other tanks. This use of wireless is of particular advantage for the transmission of orders and for obtaining directions for use by the pilots of the tanks.

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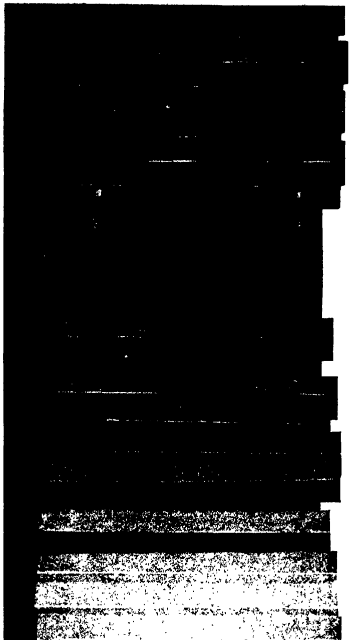
DECEMBER 1927

DEPARTMENTS



Bearing Life is Car Life

Right down where the power of cars and trucks is turned into miles, speed, profit and pleasure, the bearings are at work. Right where bumps, hills and curves try to do their worst to the chassis, only the best bearings can prevent it.

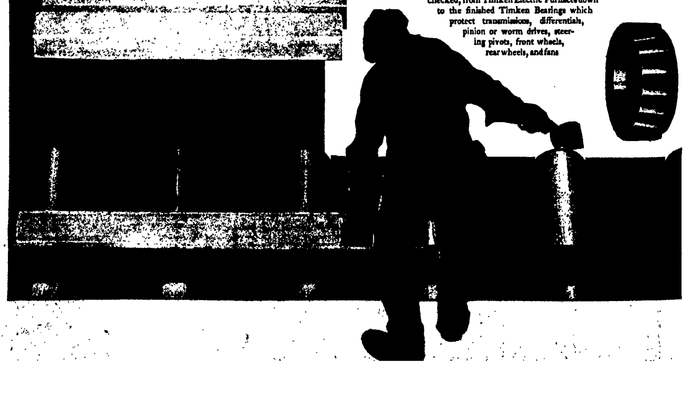
The bearings have the final responsibility. For the bearings support the gears, shafts and wheels. To a large degree car life depends on bearing life. Nothing is more important than the bearings in choosing a car, truck or bus!

Be sure the make you choose is equipped with Timken Tapered Roller Bearings. Thus you can check performance, endurance and economy in advance, as only an engineer could do. The great majority of all makes give you Timken advantages —the exclusive combination of Timken tapered design, Timken-made electric steel and Timken *POSITIVELY ALIGNED ROLLS*—the most enduring design and material ever developed for anti-friction bearings.

THE TIMKEN ROLLER BEARING CO., CANTON, OHIO

TIMKEN
Tapered
ROLLER BEARINGS

At one stage, identifying marks are pounded into each "billet" of glowing Timken Steel. Quality is constantly checked, from Timken Electric Furnaces down to the finished Timken Bearings which protect transmissions, differentials, pinion or worm drives, steering pivots, front wheels, rear wheels, and fans



Among our Contributors

PROF. ROBERT H. GAULT

Several years ago Prof. Gault of Northwestern University discovered the possibility of instrumentally communicating the vibrations of speech to the skin of a deaf listener so that words could be distinguished. Since then he has been on leave from the University, working on his discovery with the National Research Council, the Carnegie Institution and the Bell Telephone Laboratories.

COL. E. H. WILCOX

Chief Engineer of a great oil company, the author of the article on lightning prevention at oil storage reservoirs (page 489) is a native of Australia, although for 30 years a resident of the United States. During the World War he organized, commanded and served with the 543rd Engineers. As early as 1903 he designed and built the first oval-type oil reservoir holding over 1,000,000 barrels.

Dr. L. H. Dudley Buxton

On page 493 you will find a chatty, informal narrative of a little "sideshow" put on by the anthropologist, Dr. Buxton, who while on his way home from Mesopotamia discovered that the sands of Arabia are literally dotted with evidences of prehistoric man. The reader, who after reading this, does not at least *wish* he could go to Arabia and hunt for more is subnormal.

H. J. Lutz

Mr. Lutz of Yale has contributed this month an interesting account of the rehabilitation of an area rendered desolate by a glacier. It takes us into the world of plants and trees, and lays open their world and its internal struggles. Few of us realize that trees are in constant struggle, the same as animals, and only the fittest manage to survive the ordeal.

Prof. Alexander Klemin

Prof. Klemin, a Russian who came to this country from England, is in charge of the famous Guggenheim School of Aeronautics at New York University. No one in America is in a more strategic position to know what is going on in the world of aviation and to write about it. He contributes his usual department—aviation.

C. Bond Lloyd

Mr. Lloyd has approached the solution of a mooted question in the playing of golf, from a strictly scientific basis. Not that this means that he is not a practical golf player, for he is. But instead of trusting the eyes or other senses, he has attempted to measure accurately an important golf factor. Read of his experiments on page 522.

Looking Ahead

with the Editor

GAS

That's what some people do on the telephone, and those of us who get our talks over quickly have to pay for it. Why not, then, make the long-winded pay by the minute? That's just what is being tried in Everett, Washington, where every 'phone has its automatic minute-meter. How this works out in actual practice will be revealed next month.

LIGHT

There is about twenty times as much science in the science of artificial lighting as most people realize. Next month Dr. M. Luckiesh, Director of the famous Lighting Research Laboratory of the General Electric Company, will bring some of the same science out of the darkness into the light.

CRASHING

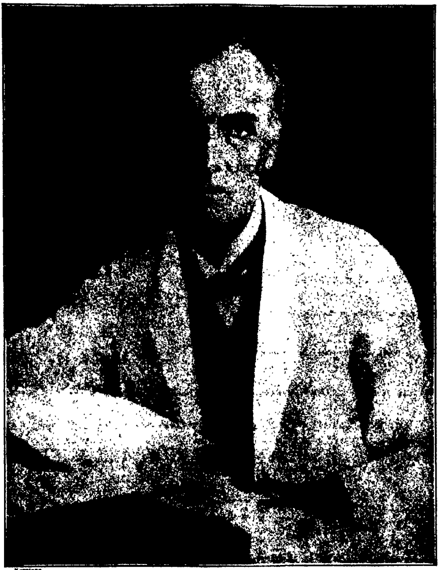
How does an airplane pilot feel when his plane crashes? What are his reactions when he finds that his plane is out of control? These and other similar questions will be answered by Lieutenant George O. Noville, a member of the famous Byrd transatlantic flight party, whose story of his thrilling experiences will be published in our next issue.

PROTOPLASM

Protoplasm lives. Everything that lives is made of protoplasm. What, then, is life? It sounds so easy, yet all we can set opposite the great enigma are theories. Professor Seifritz of the University of Pennsylvania has been performing some remarkably interesting experiments on protoplasm. They will be described by him next month.

AIR

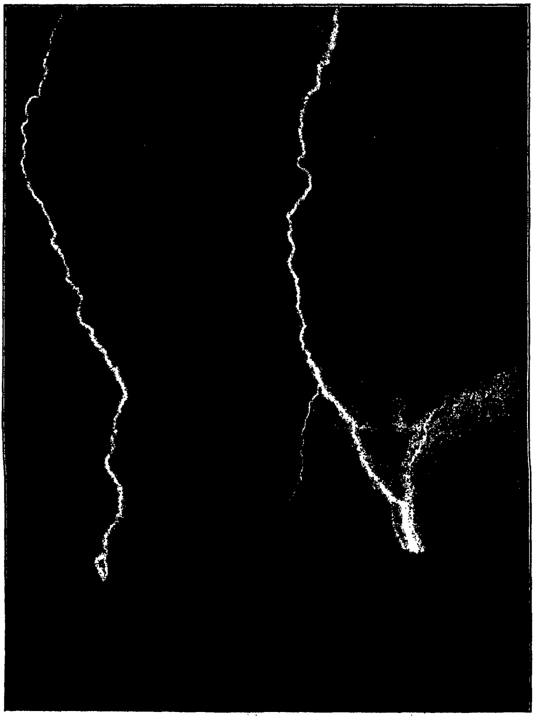
The atmosphere is so commonplace that we overlook it. Prof. W. J. Humphreys, Chief Physicist of the United States Weather Bureau has not overlooked it—in the next issue he looks it over, and tells us what new things science has discovered concerning it. Just what, for example, is in the unexplored highest levels of the surrounding atmosphere?



Keystone

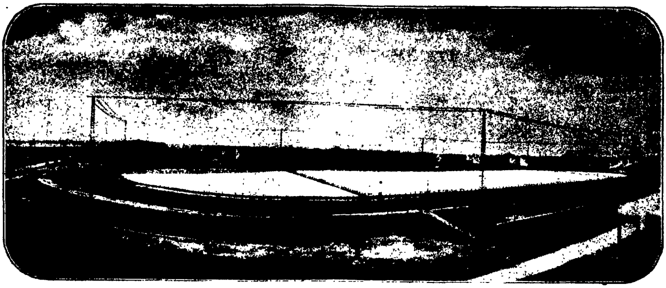
SIR ARTHUR KEITH

Famed President of the British Association for the Advancement of Science, his recent presidential address on Darwin's theory of the descent of man has attracted worldwide attention at a time when the modification of some of the minor details of Darwin's original structure appears to have misled a part of the public into the belief that "science has now abandoned Darwinism, and hence evolution." Sir Arthur pointed out that Darwin's main concept, considered the most far-reaching historical influence of the last century if not of all modern times, still stands like a rock. Author of the noted popular work, "The Antiquity of Man," Keith is possibly the world's foremost authority on the evolution of the human body from that of an anthropoid ape of the Tertiary Period of geology, a duration of a million years and probably very much more.



Lightning in Oklahoma

FREQUENTLY in the plains states, electric storms come and go at short intervals, and it may be possible when looking from a selected vantage point to see several separate storms scudding across an otherwise sunny landscape at the same hour. Amateur photographers find little difficulty in photographing lightning flashes at night, simply leaving the shutters of their cameras open for a few minutes. Despite the fact that considerable research has been performed on lightning, scientists are loath to dogmatize concerning its ways, for it is felt that much remains to be explained. Why lightning performs in what we call its normal manner is fairly well understood, as is made evident in the article beginning on the opposite page, but certain of its antics remain inexplicable. To say, however, that these antics are "abnormal," is erroneous, and is really a confession that we do not yet understand them.



HOW LIGHTNING DAMAGE IS PREVENTED

Storage tank containing 1,300,000 barrels of California oil—safe-guarded against the risk of total fire loss by means of the system of lightning prevention, not mere protection, described in the article below and illustrated in complete detail on this and the following pages

Lightning Prevention

A New Scientific Method Has Been Devised for Safeguarding Large Areas--Especially Petroleum Storage Tanks--by Actually Preventing Lightning Strokes, Instead of Merely Protecting Them with Lightning Rods

By COLONEL E. H. WILCOX

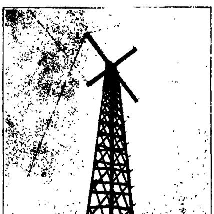
Engineer's Reserve Corps, United States Army; Chief Engineer, Pan American Petroleum Company; Member, American Society of Civil Engineers

LIGHTNING has always been regarded as beyond human control, but researches of the past year have lead to a completely revised viewpoint, and have offered to the industrial world a new system of lightning protection based on scientific experiment and research, which aims at protecting from the effect of lightning by *preventing* lightning discharges in, on, or around the objects protected.

The new system has already been adopted by the Pan American Petroleum Company, after an exhaustive investigation, and twelve and one-half millions of barrels of oil are now protected by it. It is known as the Cage system of lightning prevention, and is the invention of John M. Cage of Los Angeles.

THE Cage system primarily protects an area, and incidentally all objects within that area, whether they be tanks, reservoirs, arsenals, storehouses, or barns. It works on a theory diametrically opposite to that of the ordinary lightning rod or tower such as is frequently used for protection. A single tower or a group of towers on the theory of *attracting* discharges which otherwise would have struck objects in their immediate vicinity, and conducting the charges safely into ground, each tower being credited with the ability to protect a zone proportionate to the height of the tower.

The Cage system, on the other hand, claims to remove the danger of a discharge of lightning taking place in, on, or around the protected zone. It operates by gathering into itself the ground charges which would have existed within the protected area, and returning them to the charged thundercloud by ionic discharge, so distributed in time and in space that no destructive discharge can take place over, or within, the protected area.

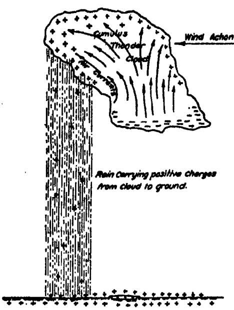


A THREE-WAY TOWER

The function of the wires shown is described in the accompanying article

THIS distribution of the electrostatic charge of the cloud over time and space instead of concentration in time and space changes the type of discharge from an "impulsive rush" or lightning flash to corona leakage, ionic discharge or dissipation, so widely distributed and so reduced in intensity as to be perceptible only to instruments of precision, removing altogether the possibility of direct flash or lightning discharge. This is not the same as the "impulsive rush" described by Sir Oliver Lodge. It denotes the alternate slow charging and instantaneous discharging of a cloud.

In practice, this is accomplished by erecting steel towers of suitable height, completely surrounding the area to be protected, these towers being connected at the top by a cordon or ring of wires arranged in a hori-



WHEN DOES LIGHTNING OCCUR?

When the difference of potential between cloud and earth charges excels the resistance of the air

zontal plane, and carrying frequent points from which discharges take place, all properly grounded and interconnected electrically with the reservoir or other object which it is desired to protect.

In order to understand the theory of the operation of the Cage system, it is necessary to know something of the formation of charges in the clouds themselves. It is no magic process which suddenly dumps an immense charge of electricity out of nowhere into the cloud. The charge therein is built up by a definite process—one which takes an appreciable time-interval for its operation. The uprushing currents of air in the cloud cause a separation of charge. In all probability, this is effected partly by subdivision of water particles as they are broken up by the air currents in the cloud, partly by jet action, but principally by the friction of the passage of air over the water particles composing the cloud. All of these act together in varying degrees to cause a separation of the positive and negative electrical elements in the cloud, resulting in the phenomenon which we know as a charged cloud.

THE negative electrons usually remain in the cloud, concentrated in its lower zone, while the positive electrons are carried upward and outward, and frequently are finally brought down to earth with the rain. This process is occasionally reversed, the positive remaining in the cloud, and the negative brought to earth. In either event, the presence of the charged cloud imposes by influence an equal charge of opposite potential on the ground beneath. This is frequently intensified by the charge brought down with the rain, while the electrons of opposite potential in the ground are expelled laterally by the influence of the cloud. This is illustrated graphically in the first of the diagrams on this page. In any event, the presence of the charge in the cloud imposes by itself an equal charge of opposite potential on the ground. When this difference of potential between charges exceeds the air resistance, it breaks through and that phenomenon which we know as a flash of lightning occurs.

Simultaneously with the occurrence of this flash of lightning or primary discharge, there may occur numerous secondary discharges or sparks of lesser magnitude in or among objects in the vicinity of the primary discharge. The explanation of these secondary discharges is that, prior to the primary discharge of the cloud in the lightning flash, the ground and all objects on it within the influence of the cloud are charged with the ground potential.

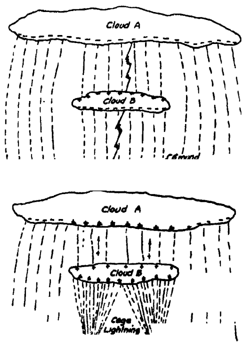
BECAUSE of the existence of the charge in the cloud, these ground charges are bound, but they seek to liberate themselves, restoring electrical equilibrium simultaneously with the primary discharge. If these charges are provided with ample direct and unbroken paths of good conductivity or low resistance to the center of impact of the primary discharge, they follow these paths and the charge is released without spark. On the other hand, if there be any break in the continuity of these paths, or if a zone of high resistance intervenes, or if they be indirect or insufficient, then the charge will spark across its line of least resistance to the ground or to a conductor leading to this center of impact.

These sparks may vary in length from the infinitesimal to several feet, depending altogether on the circumstances in each individual case, the intensity of the charge, the capacity of the body, and its distance from the center of primary discharge. In any event, the secondary spark, whether small or great, is a source of grave danger, being probably responsible for many more fires than are primary discharges. Should this spark, no matter how small, occur in the presence of any inflammable or explosive gases, disaster follows immediately.

Lodge's conception of "impulsive rush" is that a large and highly charged cloud at a higher elevation suddenly unloads on a neutral cloud beneath, which cloud in turn, being suddenly overloaded, dumps its charge to earth. This idea comes from a false analogy. There is no similarity between it and pouring a stream of water from an elevated vessel into a lower one until it shall "tip," as it were, dumping its contents on the ground beneath.

THERE is no such thing in nature as a highly charged high cloud and a neutral cloud beneath, unless we assume the false premise that the lower cloud is equally non-conducting with the air in which it floats. A cloud is not as good a conductor as metal, but it is far from being a non-conductor. Under the influence of the charging cloud A, (see the second diagram on this page) there will be a separation of charges in B, positive concentrating in the upper and negative in the lower portions of the cloud, with such stray lines of force as may be reaching the earth direct. Here, the stress is primarily between the two clouds, with a secondary stress from the lower portion of the cloud to the ground.

In such a situation as assumed by Lodge, with a Cage dissipation system functioning, the cloud B would not



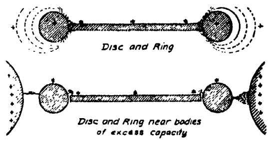
IS SIR OLIVER LODGE WRONG?

According to the author, his "impulsive rush" concept is incorrect. See the accompanying text

hold an equal separation of positive and negative charges, the negative in the lower portion being constantly neutralized by the upward convection currents of positive ions from the ground. It would, therefore, tend toward an excess of positive. Meanwhile, other positive ions from the ground are also neutralizing the charge in cloud A. If a discharge of any kind could occur under the circumstances, it could be only between clouds A and B, as the stress between the ground and B has been relieved. Any discharge would neutralize A and B, or neutralize B with reduction of charge in A, depending on the relative capacities of the cloud. It would so reduce stresses between A and the ground that there would be no possibility of discharge between them. This brief picture of the nature of lightning is necessary to enable the reader to understand its action.

THE new system of lightning prevention aims at the reduction of the charge in the cloud by gathering up into itself the earth charges within the protected area, discharging them to the cloud in such degree and manner as to neutralize the cloud charge so that no primary discharge of any kind can take place.

A few simple but fundamental electrical and magnetic phenomena will help to make this action clear. If a disk of metal be completely charged with electricity of either potential, this charge will be found to reside most strongly on the periphery of the disk, and almost lacking at its center. If, now, an encircling ring be brought into contact with the disk, the charge will be found to have left the disk and to be resident in the ring up to the capacity of the ring to receive it. If this ring in turn be connected to a receiver of unlimited capacity such as a ground, or if means be provided by which the charge can again pass to this receiver, both disk and ring will quickly be completely discharged. This is shown in the third of the diagrams, reproduced at the right.



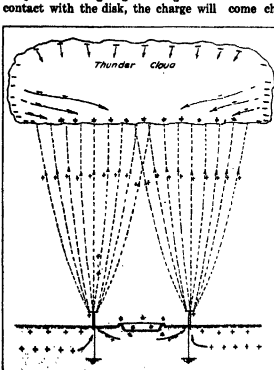
EXPLAINING THE NEW SYSTEM

A simple little experiment which can be performed by anyone with simple equipment

If two metal spheres of equal diameter, charged with electricity of opposite potential, be approached but not brought within sparking distance, it will be found that these charges will persist for long periods of time. If, however, one of these spheres be provided with a sharp point, directed toward the other, then the transfer of charge will be greatly accelerated and in a brief period of time both bodies will be completely discharged.

These principles are now being recognized and made use of. A cordon or ring of wires around and above the protected area is brought into electrical continuity with that area and with every object within which it is desired to protect. This results in an immediate tendency for outward flow of the previously bound current to the wires.

THIS, however, would have little if any effect if the protection stopped here. The wires would speedily become charged to their capacity and the interior charges would not be materially affected. However, these wires are provided with numerous spaced sharp points from every one of which these charges can pass by corona discharge, ionic leakage, or dissipation. The liberated ions carrying these charges go directly to the nearest body of opposite potential (which in this case is the cloud), each positive on its arrival seizing, satisfying, and neutralizing a negative, thus removing potential from the ground and neutralizing that in the cloud. This is illustrated in the last diagram on page 491.



HOW IT ACTUALLY WORKS

From the wires the corona discharges pass, continually neutralizing the charges in the cloud

The practical questions which presented themselves for solution were: At what rate can such a system liberate its charge to the cloud by dissipation, or ionic leakage? What can be known of the charging rates of the cloud and the amount of energy which must be taken into consideration in order to assure complete protection? What must be considered as the minimum area of cloud and ground which must be included in such a system, in order to be effective? What general mechanical arrangement will give the optimum combination best to produce the desired results?

Numerous experiments by the inventor and the writer, extending over some eight months of time, were necessary to answer these questions. Naturally, many false steps were made, as there was comparatively little in past experience to guide us. Many types and combinations of points and wires were tested. Finally, a three-wire system was determined as giving the optimum results.

EXPERIMENTAL work was carried on in two laboratories. For qualitative work, a miniature "cloud" consisting of a disk of small mesh wire netting about five feet in diameter, with a heavy wire ring reinforcing the perimeter, was used. The cloud was charged with direct current, both negative and positive potential being used, and observations and measurements were made with respect to miniature oil reservoirs beneath. A cloud thus charged would spark across six to eight inches of air to the unprotected reservoir or tank, while the same cloud could only spark across approximately one-fourth inch with the protective system in place, this spark invariably being to the protective system, never to the oil. In other words, the voltage stress between cloud and ground was reduced from that necessary to break down six to eight inches of air dielectric—say 60,000 volts—to that necessary to break down one-fourth inch—say 2500 volts.

3,241,000 BARRELS

000 barrels of petroleum, ... in the foreground. The Cage system, so called because invented by Mr. ... M. Cage, protects both reservoirs by ... venting lightning, a ... proverbial "ounce of p...

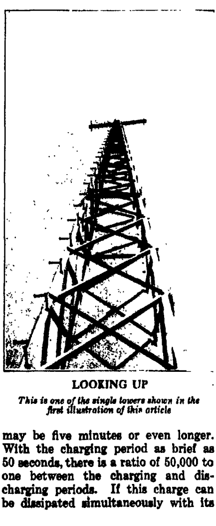
The quantitative tests were made in the laboratories of the testing department of the Southern California Edison Company at Alhambra, where there were available transformers with capacities of 250 kilowatts and 250,000 volts. Here sparks 31 inches long could be secured. As these could not safely be struck to oil-filled vessels, metal tanks were substituted. A metal cloud 12 feet square and a dissipating system with external dimensions 10 feet square were used to determine the amount of current that would flow, without flash, by corona discharge, dissipation, or leakage, at varying gradients. Alternating current only was available.

Our practical installations consist of a system of three parallel wires arranged in a horizontal plane and spaced four feet, center to center, with dissipating points at intervals not to exceed six inches, which repeated experiments showed to be about the optimum spacing for such a system.

IT is interesting to note that with a high hanging cloud, there is much greater unit value of discharge at a given gradient than with a low hanging cloud. This has been confirmed by numerous experiments. As all laboratory experiments were made with comparatively low hanging clouds, this gives a promise that the dissipative action of a system may be even greater than the experiments indicate.

There is a great popular misconception as to the amount of electricity in a lightning flash, and the power which it represents. This is due to its spectacular appearance, its little understood and apparently uncontrollable nature, and to the disastrous effects which occasionally follow a discharge. This is not a proper basis on which to judge. A stroke of lightning may split a tree, but so will a stick of dynamite. A stroke of lightning may fire a barn, but so will a match. Lightning produces disastrous results because of its intense concentration both in time and in space, rather than the large quantity of electricity in it. The duration of a lightning flash is extremely brief, frequently less than one one thousandth (.001) part of a second, and this released energy is confined to a very narrow channel, the path of the flash. This path is seldom if ever greater than from four to six inches in actual diameter. Thus there is intense concentration both in time and in space in the lightning flash.

The building up period of the charge, so released, takes an appreciable time. It may be as short as 50 seconds. It may be five minutes or even longer. With the charging period as brief as 50 seconds, there is a ratio of 50,000 to one between the charging and discharging periods. If this charge can be dissipated simultaneously with its generation, and not allowed to accumulate to the break-over point, so releasing itself in an "impulsive rush," a very small amount of energy is all that need be handled in a given unit of time.



LOOKING UP

This is one of the single towers shown in the first illustration of this article

Analogy will perhaps best illustrate. Imagine a water tank on top of a very high tower. Into this tank a constant stream is flowing, this stream representing the charging rate of the tank (or cloud). Numerous small holes radiate outwardly near the bottom of the tank and are so arranged as just to balance the incoming stream when the tank is nearly full. These numerous small streams, falling from a great height, acted on by wind currents, will be broken up into tiny drops, and will distribute themselves as a gentle rain over a considerable area. This is distribution of the incoming charge in time and in space. It can go on indefinitely without harmful result.

On the other hand, think of this same tank without any such relief, but so designed that when the water reaches within a few inches of the top, the tank will suddenly tip, releasing its entire charge at once. This will come as an "impulsive rush" or deluge on the ground immediately beneath the tank, probably washing its foundations away. This is concentration in time and in space.

IN each case the amount of water handled over a given interval of time is the same, but in the first instance, the discharge is harmless and in the second it is destructive.

The action of a properly designed Cage system, under the influence of a charged or charging cloud, will be that, as the charge begins to build up in the cloud, a small but steady release of ground charge back to the cloud will occur. Until this rate of discharge balances the charging rate of the cloud, the potentials between cloud and ground will rise. This rise in potential means in turn an increased rate of discharge from ground until equilibrium is established, at which time the discharge of current from the earth to the cloud will balance the charging rate in the cloud itself. When this point is reached, equilibrium will be maintained and at a potential gradient so low that there is no possibility of a lightning flash.

MORE PREVENTION

Still another vast California oil reservoir, holding 4,090,000 barrels, safeguarded by the Cage invention. Due to a temporary over-production, the producers recently faced the necessity of storing immense volumes of petroleum in open reservoirs

Pre-Sumerian Man

From Unknown Arabia New Evidence of Prehistoric Man of as Early as 20,000 B. C. Has Been Discovered

By L. H. DUDLEY BUXTON, M.A., F.S.A.

Published by courtesy of Discovery (London)

OUR journey, from Kish, in Mesopotamia, to Jerusalem, was one of the most interesting and fruitful times I have ever spent, and even now it seems hard to think that we packed so much into four days.

On our way out we had found some stone implements which, while undoubtedly the work of early man, were few and indefinite; we wanted to find more. Fortunately for ourselves, on the return journey the Air Vice-Marshal gave us permission to go out into the desert with the armored-car patrol, and we practised archeology under extremely strange conditions.

Our party included Henry Field and myself, archeologists and civilians, and a detachment of the Royal Air Force, with armored cars. I think that we were first of all regarded as extremely mad; out East, however, the afflicted of Allah are always regarded with compassion, and before very long the detachment were as afflicted as ourselves—but that is a story I will tell in its proper place.

We did a short journey the first day along the Euphrates to a place called Ramadi, which is a "desert port" in the same sense that the camel has been called, *ad nauseam*, "the ship of the desert." All along the Euphrates there are a series of towns from which the caravans start out on their hazardous journey across to the Mediterranean; west of them there is no permanent habitation until the borders of Moab are reached. For ourselves—for the armored cars were coming back the same way—there was one place where water could be obtained, and only one, after we had left Ramadi.

WE started off at dawn and it soon began to rain—not desert weather, perhaps, but it does rain even there—and we were miserable till lunch time, when it cleared up, and we halted in rolling country, to make our first find, a flint implement, but not of any type which could be recognised. We halted for the night nearly 200 miles from Ramadi, at Rutba Wells, our one watering place.

I was the only person in the party who spoke Arabic, and that not well, so it fell to my duty to accept the hospitality of the desert police, while Field hunted for flints and only found one, and the detachment worked at the cars. I sat cross-legged on a sheepskin in a black Arab tent, drank tea and coffee and smoked, and got several useful pieces of information. I asked whether the Arabs ever used flint to-day as knives, and showed them some I had found on the way out. They were very scornful. Those were of no use; the Bedouins sometimes used flints to make fire, but not useless pieces like that. I had one or two flakes that looked very modern, but the people who use the strike-a-lights repudiated them. This was certainly quite an auspicious beginning.

Then I asked about old ruins. Were there any in the desert? They told me there were some at Nazr, a few miles away, and that there was a well there too, but dried up. Beyond that they knew of nothing. So we talked and smoked and drank coffee. All this sounds very prosaic in the telling, but in an Arab tent with a lantern hanging from the pole, a brazier of camel thorn giving an intermittent red glow, and a gathering of swarthy-faced desert police, hung around with scimitars and other lethal weapons, it was really a very pleasant way of spending an evening, although so far our quest had been unsuccessful.

Next morning we soon came to Nasr. This place was of particular interest because it was to shed further light on a problem met with on our expedition to Kish. We had there excavated a site in the desert south of Baghdad called Jemdt-en-Nasr, and I was of the opinion that the name Nassar or Nazr was that of a local saint—the word actually means "savior." The name is a common one in many parts of the middle East, and we had, as a matter of fact, had a servant of that name at Kish. On the other hand, Professor Langdon was at first inclined to believe the name to be a survival of a vague memory of Nebuchadnezzar, in much the same way perhaps that in Cyprus, for instance, to-day it is perfectly certain that modern saints preserve a memory of forgotten ancient shrines.

IN this case the name would be an indication that there existed a city whose very site perhaps has been forgotten, but whose vague memory has lingered on for so many centuries.

Nazr was easy to find, as the desert police gave us clear instructions, but although we searched carefully we got no definite archeological data. There were some vague stone ruins of a well, now dry, but beautifully preserved, the construction of which can be seen in the accompanying illustration; and that was all. There were no traces of the potsherds or bits of broken crocks which strew the ground in their thousands on any old city site, and had there formerly been any settled habitation on the spot even our short visit would have shown us at least some traces. But there was nothing, just a few stones, obviously the foundation of some post, possibly a *qsar* or guardhouse on the road, and a well—nothing to indicate that many men had once lived and fought and died in this remote spot.

The name Nazr, then, at least in this instance, turned out to be unreliable as a guide to the finding of ancient Babylonian cities, and the Professor and I are now inclined to regard it as a name of a local saint whose origin, however, is as yet obscure.

We climbed into the cars again and went farther into the wilderness. Sixty miles from our starting-place in the morning we punctured a tire—a fortunate chance, for while the detachment labored with the huge tires, Field and I ran round, eyes glued to the ground, and began to find things. We each

What Will Arabia Reveal?

ARABIA is a land of mystery. Only a handful of daring explorers have crossed its arid, burning desert, braving its wild tribesmen. Of these the author of the accompanying article, a noted British anthropologist, is one. Finishing a season's excavation at Kish, in Mesopotamia, with the joint expedition of the Field Museum (Chicago) and Oxford University, he, with Mr. Henry Field, returned by way of the Arabian Desert. There they hastily sought and found evidences of ancient man. The fact that Europe abounds with such evidences shows merely that more searching has been done in Europe. Asia will bear watching.

The Editor

went out in opposite directions, although never more than a hundred yards or so from the cars. Every now and then I heard Field shout "got one," as he stooped down and picked up an implement. This unknown spot in the wilderness gave us some of the most definite information we obtained about Paleolithic man. If anybody wants to go and find more—and there are plenty to be found—it is close to Landing Ground R, (see map, page 495), which is marked on the air maps, and on the map the Royal Geographical Society has published of this area.

I did not realize the importance of my finds here until I went over them later, and they provided me with definite evidence of late Paleolithic man of the period usually termed Aurignacian, in Europe, about 20,000 B.C.

After the puncture had been mended, we had no more luck, although we stopped once or twice. We halted for lunch at a crashed airplane. The spot is known universally as Maitland's Monument, after the name of the man who crashed, though he was not killed. We searched here again very thoroughly but found nothing, and stopped for the night about a hundred miles farther on, at a place nearly surrounded by low hills and enclosing a shallow desert lake. Here we had found implements on our way out, and we hoped for great things. It was getting dark when we pulled up, but we had a look round and found a few flakes.

THAT evening, after the cars had been nursed and put to bed and the day's work finished, the men made a fire of camel thorn and asked me to tell them something about Paleolithic man. I have seldom had so keen an audience—there was a little circle seated on empty petrol drums, the firelight flickering on their faces, and outside the circle nothing but the wilderness. So I told them what little I could about the people who lived in that desert probably more than a hundred centuries ago. A man every now and then heaped more fuel on the fire from the pile they had gathered and Field demonstrated on the implements that we had found. The lecture was not perhaps very highbrow, but it had great practical results. The rest of the time the men spent their scanty leisure looking around and found quite a big proportion of our specimens.

Then the men cast lots for turns at guard. On the desert patrol the officers take turn and turn about with the men under their command, and our host had the first watch. I suggested sharing it with him, so we inspected the camp and put out the fire lest we should be a mark to desert raiders. We walked around and around the cars, and talked softly of what the place must have been like when the makers of the implements lived there. Great changes have clearly taken place. The spot was at least a hundred miles from the nearest permanent water. There was a little pasture when we were there and some water in the desert pools, but in the summer the ground is parched and dried up. To live there without camels would be impossible, with them difficult, but the desert Bedu seem to survive on only camel's milk, and the camels are the nearest thing to perpetual motion in producing milk without much pasture that ever existed. But even the most hardy Bedouins could not live there permanently.

ANCIENT WELL AT NAZR

Not, however, the work of prehistoric man. Arabia's climate has not always been arid, geological evidence shows

Yet we found definite evidence that man had, long ago, lived there and up on the high desert near Landing Ground R. Further, there is no evidence at present that Paleolithic man ever domesticated camels, although the history of that animal's association with man is not very well known. The problem seemed a difficult one, and my host was inclined to suggest that the stones were made by Bedouins, though he admitted that they were obviously very old, as the surface even of the worked parts was highly polished by the action of the wind blowing dust against it. Such polish takes a long time to acquire.

However, the solution is fairly simple. In western Europe, where the Old Stone Age has been thoroughly studied, we know that during that period the climate was very different from what it is now, and that the ice-cap reached much farther south. Climatic conditions over the whole world must have been very different, and there is every probability that there was a good deal more rain in the north Arabian desert. It is unlikely that there was ever any heavily-forested region there, but a little more rain would serve to convert that poor steppe into quite habitable country, and make it possible even for primitive hunters to live there. After we had gained a little more experience, we found that worked flints were found principally in small hollows and little dry valleys, although this was by no means an invariable rule. It may well be that in the remote period, when man was living there, water flowed down the valley bottoms, and possibly there were even burbling streams.

SO we talked under the stars, watching the horizon with our field-glasses at intervals, but we saw nothing and turned in when the end of our watch came. Next day as soon as breakfast was over, Field and I started out. We were told not to go out of sight of the cars, and we put on revolvers to signal with if we saw anyone. I have never done archeology before looking as if I were prepared to repel boarders or engage in other military feats of arms.

We met with no adventures and made many finds, some obviously very early flints and others of later date. At the bottom of the hollow, near the Air Force Landing Ground H, we found a large lake possibly a hundred acres in extent and nowhere more than a foot or so deep. Owing to some trick of Nature there were clearly two surfaces. On the one we found no evidence of man's handiwork. The lower surface, about a foot deeper, seems to have been exposed in ancient times, and here we found a large number of small flint tools. Luckily, in some places the upper surface had been removed by wind or other action, and the older floor was exposed. We wandered about for some time before we understood exactly what had happened, and we were disappointed that at first we found so little. Afterwards we knew where to look.

We returned to camp with full pockets and very sore heels, to find that after the cars had been cleaned and looked over, the detachment, instead of going to sleep—which as the sergeant said to me was "indicated"—

had turned themselves into archeologists and had searched for flints. What is more, they had found them, and flints of a later date than those we found at the bottom of the depression. I cannot say why at one time man had lived in one spot and later migrated to another higher up on the hillside, but at least in that place they did, possibly owing to a change in climate.

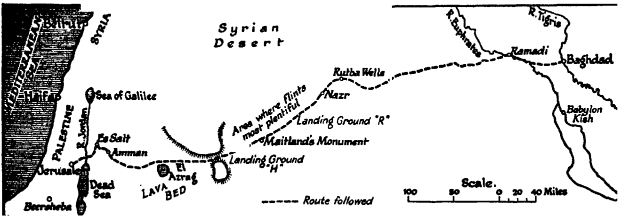
During the afternoon we met a tribe of wandering Bedouins on the move—a singularly Biblical occurrence, for while peace was literally on my lips (for that is the desert greeting) we made ourselves ready for battle, without fortunately having to do more than make a demonstration. We slept one more night with the armored cars, and got up at dawn to wait for the mail convoy which was going to take us on to Jerusalem. It was icy cold in the grey before the dawn, although so hot in the daytime, and the men called it "a short course in death," but a fire of camel thorn soon gave us hot tea and rabbit stew and we then felt better.

THE convoy came along and we said goodbye to our excellent hosts, who started on their 500-mile journey back to garage after doing a little more patrolling to see that the King's peace was being kept. We had a few punctures and found implements at nearly every stop.

When we arrived in Jerusalem our pockets were bulging and Field's attache case was overburdened, so until we reached home again we hardly knew what we really had found. A careful examination later, however, showed us that our finds belonged to the middle and later periods of the Old Stone Age, probably the oldest dating from as early as 20,000 B. C. We also found a beautiful little laurel-leaved arrowhead belonging probably to the New Stone Age.

Briefly the conclusions which can be drawn from the evidence collected are as follows: In the valley of the twin rivers only material which suggests a fairly advanced culture has been found, nothing primitive has come out of the mud of the Tigris and Euphrates. Here, on the divide between Mesopotamia and Palestine, we have definite traces of the existence of man in all likelihood very many hundred if not thousands of years before the rise of the great Sumerian civilization. We have evidence which suggests an entirely different climate and conditions from those which prevailed in Mesopotamia since the earliest times we can trace in that region.

Although many of the implements were found far away in the desert, yet we found a few quite close to the River Euphrates. We searched carefully in Mesopotamia itself and found nothing very early, nothing before about 3500 B. C., a long time ago but only a short time compared with the immense period which must have elapsed since Mousterian or Neanderthal man hunted on these wild uplands. My little arrow-head may possibly bridge the gap to a certain extent and indicate a race of more advanced hunters, but it is by itself uncertain evidence.



MAP OF THE AUTHOR'S JOURNEY FROM MESOPOTAMIA TO PALESTINE

The trip traversed the northern portion of the great Arabian Desert, which stretches for hundreds of miles to the south and is peopled with tribes even wilder than the Bedouins—in fact there are tribes which the fiercest Bedouins fear

MOUSTERIAN AX

Type of workmanship performed by Neanderthal man, 50,000 years ago

The Sumerians were very accomplished agriculturists, using an elaborate system of irrigation. Such a system, although when learned from other more advanced peoples may be practiced by comparatively primitive peoples, takes many years to build up. The Sumerians, however, were far from being primitive; they had behind them a long and elaborate but as yet unknown history.

THESE flints take us back into another world. We do not know, of course, what Mesopotamia was like, nor do we know what was the relationship between the valley people and the highlanders. The former may have already been quite advanced, but we have now definite evidence that there was a culture which definitely preceded the earliest Sumerian city known. There is a gap which is yet to be filled. We have primitive hunters on the plateau long before the dawn of history, away in the valley, at about half the distance between London and Edinburgh; we have possibly thousands of years later, when history begins, an advanced civilization. The evidence for a Babylonian culture on the plateau is, I have tried to show, doubtful.

One further point remains. Man is known to be conservative in his physique more than in his culture. It is a noteworthy fact that in ancient Kish and to-day among the modern Arabs there survives an ancient physical type, closely resembling a type living in western Europe in Aurignacian times. It is tempting to suggest that the ancient Kishites and their modern representatives are the actual descendants of the primitive pre-Sumerian hunters who were living in the North Arabian desert many years before it became a desert.

OUR POINT OF VIEW

HARPIES

THAT inventors are tempting prey for unscrupulous sharpers and shysters is one of our traditions, but, in the case of this tradition, there is much truth in the belief.

The plans of the schemers seem all the more plausible because they apparently ask no money from the inventor, but only a percentage of what they make for him. For example, a firm of "patent promoters" would obtain an inventor's name from the Official Gazette when his patent issued, and begin correspondence which terminated in a contract by which the "promoters" would undertake to sell the patent for a percentage of the selling price.

A month or two later the inventor would be informed that the promoter had a buyer who would take the patent over, provided the patent was valid and the article could be manufactured economically. To satisfy the prospective customer, the promoter had to make an "engineering and patent report." This the promoter will gladly supply upon receipt of 25 dollars, (although a really comprehensive and valuable report costs several hundred dollars). When the inventor paid his fee and the report was made, the interest of the prospective buyer had evaporated; in fact, the patentee never learned the identity of the mysterious buyer.

While the Post Office Department ended the activities of a group operating in that manner, there now is a new scheme in operation, a variation of the former which is just as dangerous. The inventor receives a letter from a firm of so-called promoters, saying they are interested in the patent he has just obtained, and asking him his selling price. The inventor sets a price, whereupon he is told that a sale can be made if he furnishes a favorable "infringement report." For this purpose the promoter recommends a Washington attorney whose opinion would be acceptable to the purchaser.

If the inventor retains the attorney suggested to him, he can expect one of two things, either that the unnamed prospective buyer has changed his mind, or that the "infringement report" is unfavorable. In any event the inventor has paid a fee and has nothing to show for it but his experience.

ROMANCE OF RAILROADING

ANYONE who believes that romance has passed entirely out of modern life should have sat with the writer on the grandstand at the Centennial Pageant of the Baltimore and Ohio Railroad and watched the historical locomotives of the past 100 years pass by in stately procession under their own steam. Headed by the diminutive "Tom Thumb" of 1829, built by Peter Cooper, there followed in their historical order some two dozen locomotives, nearly all of them the originals. It made one feel as though the long-familiar drawings from books of early locomotive history had come to life, clothing themselves in actual iron and steel, and had gathered at the call of the Baltimore and Ohio officials to render this extraordinary pageant the great success that it was.

God bless the genius on the staff of the Baltimore and Ohio, say we, who gave us this this faithful historical display. It should be made permanent, let us say in Washington or New York.

WHY NOT THE "AMERICA'S" CUP

AMERICAN sportsmen have been frank in their admiration of the feat of the Scandinavian yachtsmen, who have "lifted" two famous cups in the recent 6-meter boat contests on Long Island Sound. In doing this they met the best boats of America, Great Britain, Denmark, Holland and Italy, and defeated them so handily that American yachtsmen frankly admit that the Scan- [illegible] esent a [illegible] r yacht design over anything we can turn out today. The victory of the Scandinavians will be excellent for the promotion of the sport.

The designer of the Swedish *May-be* should be able to turn out a worthy challenger for the America's cup. He need not go above the length of 65 feet waterlin s. The America's cup contest needs revitalizing. A challenge by Sweden [illegible]r Nor[illegible]way, because of the recent [illegible]tories, would arouse enormous [illegible]

WOE TO THE FIGHTING PLANE

ONE of the most commendable and successful post-war activities of the army is the institution of the Army Ordnance Association, which seeks to hold together, in fraternal military interest, the thousands of civilians who gave their time and services to the country during the war. An important annual item in the activities of the Association is its gathering at the great Aberdeen Proving Ground to witness an exhibition of the good work which is being done there. Most reassuring to those who feared an early loss of interest in ordnance similar to that which had occurred after other wars, is the fact that the attendance has grown from so many hundreds to a total of some five thousand, which was approximately the number gathered at Aberdeen during the October meeting.

For the entertainment of the visitors, the Army Ordnance prepared a program which really consisted of a working exhibition of the very fine new ordnance developed since the war, which we illustrated in our issue of July last.

Most realistic was an attack by tanks on a line of machine-gun nests, upon which they advanced remorselessly, to climb over and flatten them out under their great weight. But the most impressive and spectacular work was that done by the anti-aircraft batteries in repelling a night attack by airplanes. The target, towed at a height of 7500 feet and at a distance, on a straight line from the guns, of two and one half miles, was quickly found and cut down.

SNOW REMOVAL PAYS

THERE are 36 states situated in the snow belt of the United States. The first flurries of snow have been reported and the season is close at hand when every state and local community should be prepared, with prompt and effective snow removal measures, to keep clear the highway routes.

The American Motorists Association states that the motor vehicles registered in the 36 states of the snow belt involved a purchase cost of seventeen and one-half billions of dollars, and it estimates the amount required for their upkeep in tires, garages and fuel at over five billions of dollars annually. Now, unless effective snow removal measures are adopted, there is no return on this huge investment of over twenty-two billion dollars, for periods ranging from a few weeks to several months.

This is a problem that seriously affects, among others, the farmer, the school, and the postal service. Snow and ice accumulations on the highways prevent the transport by farmers of their products and supplies during the closed season.

It is estimated that this season, in the 48 states, 750,000 pupils will be transported to the 15,500 consolidated schools in motor buses, and an equal number in other types of vehicles.

Consider the postal service. The Post Office Department advises that 81,600 rural free delivery vehicles use 869,000 miles of roads over the 36 snow states, and serve 21,206,400 patrons. This vital service can be rendered without interruption, only if the highways are continuously kept clear of ice and snow.

Life-Saving Airplanes

Aircraft Are Now Employed For Carrying Life-Lines to Ships in Distress

By S. R. WINTERS

OVERTHROWING a precedent of nearly one hundred years duration, something new—the airplane—enters the service of life-saving. The present-day interest in aviation, stimulated to the point of accepting the miraculous, finds added impetus in an invention of Lieutenant-Commander C. C. Van Paulsen. About five years ago, Commander Van Paulsen quietly began experiments at the recently abandoned aviation station at Morehead City, North Carolina, and has perfected a revolutionary method of throwing out rescue lines by aircraft. This method has been adopted at two aviation stations of the United States Coast Guard, located at Gloucester, Massachusetts, and Cape May, New Jersey.

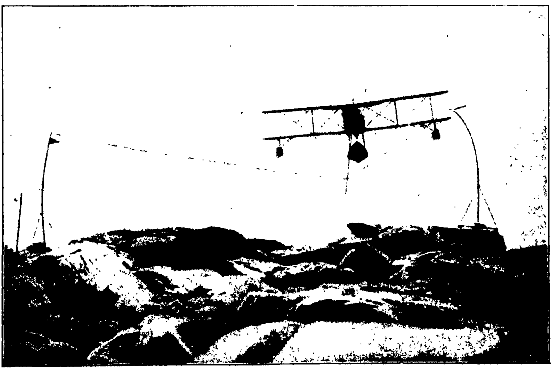
The old tar who related his narrow escapes and gave full credit for his deliverance to the "breeches-buoy" would indeed have something to tell for the rest of his days, should be be saved by aircraft. Various methods have been practiced for rescuing ships in distress, but those of the old school most frequently refer to the "cannon." Briefly, this system made use of a miniature cannon, from which was shot a projectile, with life-line attached, to the ship in distress. The stricken crew seized this line and made fast a cable carrying a large life-preserver to which was attached a pair of canvas trousers, with lines for hauling the "breeches-buoy" to and from the disabled vessel. One by one, the stranded crew stepped into the "breeches," which formed a sort of cushion for the life-preserver, and were towed safely to shore.

AND now, the airplane has been accepted by the Coast Guard of the United States Treasury Department as the vehicle for carrying out the life-line to ships in distress. In this radical safety measure, the line on shore is coiled around a number of upright sticks, attached to a wooden frame. The rope is so wound around these sticks as to pay out freely when an airplane is taking the line to a disabled vessel. The end of the life-line is led through clips to the tops of two slender masts, which are planted on the shore, spaced about 200 feet apart, and landmarked by fluttering pennants.

Immediately upon intercepting distress signals by means of the radio equipment aboard, the airplane takes off, picking up the rope, which is held taut by the masts. The method of this pick-up is unique, although by no means difficult in procedure. A rope of the usual clothes-line variety is suspended from the craft and a weight attached to the floating end keeps it in a more or less stationary position. By flying low, the rope from the airplane intersects the rope between the poles, and the weight intervenes to prevent it from slipping. The rescue rope, released from the poles, is then carried seaward to a point within reach of the distressed vessel.

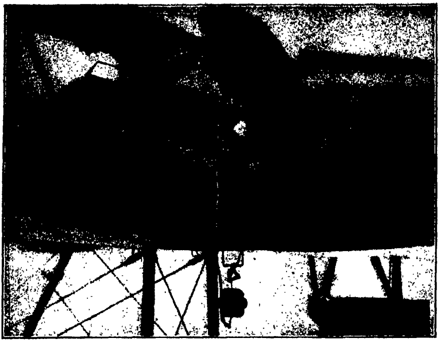
The pick-up line, once caught in the rigging of the disabled ship, or otherwise secured on board, performs the function of trailing aboard a larger line to which is attached the end of a hawser. To the latter is attached a "breeches buoy," the life preserver and canvas trousers employed in the time-honored method of rescue. This buoy, with simple tackle, is detailed on its life-saving errand, bringing the crew and passengers safely ashore.

That the airplane is quicker and more certain than the old method, is attested by the fact that in a recent demonstration, 27 life-lines were shot from a miniature cannon mounted on



PICKING UP THE LINE

A light line, exaggerated in our illustration for the sake of clarity, is stretched between two poles and held by means of spring clips. It is picked up by a freely swinging weighted line which is seen suspended from the fuselage of the plane



THE WEIGHTED PICK-UP LINE

The aviator is here shown adjusting the releasing mechanism

a Coast Guard cutter, before contact was established with a ship on the rocks. Then, too, the record distance covered by a line ejected from such a contraption is 695 yards, while the new method of delivery is said to be capable of carrying a rescue line a mile or more.

Certain limitations, however, attend this new means of extending succor to disabled vessels. For instance, a seaplane cannot take off from rough waters, and should it take off from still waters the chances are it would be too far removed from the wrecked ship to offer the needed assistance. While a land plane in this case might be able to take off from a nearby shore, a forced landing would render it helpless. In recognition of these handicaps, the Coast Guard is using amphibian aircraft at the aviation stations where this method of life-saving has been introduced. This, of course, means that the planes used in carrying rescue lines to disabled ships can take off from either land or water —preferably from the former, owing to the usual high winds encountered near a storm-swept vessel.

ANOTHER possible application of airplane activities as an aid in lessening the hazards of seafaring is suggested as a result of the success of conveying life lines. Menacing icebergs that threaten life and property in the traffic lanes of the North Atlantic Ocean have proved stalwart foes to attempted placements of TNT. The reason for such a slight degree of success in the proposed explosions is due to the difficulty encountered in a true placement of the Now, by means of amphibian planes it should be relatively easy to get a line over the top of an iceberg for the attachment of a high explosive bomb.

Maintaining more than 250 stations, stretching along the 10,000 miles of treacherous coasts, the Coast Guard was authorized under the provisions of the First Deficiency Act of 1926, to maintain and operate five seaplanes for use in performing the duties with which this branch of the service is charged. The five new planes are developments of army and navy aircraft features and are designed to give maximum cruising distance. Arrangements for the construction and operation of these planes were made under the general direction of Lieutenant-Commanders S. S. Yeandle and E. F. Stone, and the army and navy officials extended every possible co-operation. Two types were decided upon—the OL-5 amphibian and the UO-4 seaplane. Three of the former and two of the latter have been constructed.

The OL-5 amphibian planes, which have proved peculiarly adaptable to life-saving work, are equipped with inverted Liberty engines; gas capacity 140 gallons; estimated cruising radius 500 miles at a cruising speed of 75 knots; speed range 55 to 108 knots; equipped with Lewis machine-gun; and have weight and space allowance for radio installation. These planes are capable of landing on and taking off from the water and good flying fields. They are of the three-seater type and have a 45-foot wing span. Two amphibians and one seaplane are stationed at Gloucester, Massachusetts, while the other amphibian and seaplane are assigned to Cape May, New Jersey.

PARAMOUNT among the duties of the Coast Guard is life-saving and rescuing seafarers from peril. More than 200 life-saving stations are maintained on the coasts of the Atlantic Ocean and the Gulf of Mexico alone—each manned by a crew of seven to ten men. They are subjected to a rigid course of drills and well-defined duties, which necessitates their keeping long day and night vigils for disasters on gulf or sea. The life-saving apparatus of every Coast Guard station includes a surf boat with air chambers to make it unsinkable; a self-righting and self-bailing boat equipped with gasoline engine, sail and oars; a "breeches-buoy;" an iron-covered life car capable of carrying five or six persons at a time, and operated like a breeches buoy; a bronze cannon capable of shooting lines up to 600 yards; a rocket with a coil of rope at its head which is sometimes used instead of the cannon, and which can

WINDING THE LINE

This method of folding the line to be carried out to a ship eliminates any possibility of a troublesome tangle

travel 1000 yards; beach cart; pulmotor; and now an amphibian plane for rescue work.

That the added duty of apprehending rum-smugglers has not decreased the life-and-property saving efficiency of the Coast Guard service is attested by the following statement, made by Lieutenant Commander Stephen S. Yeandle, aide to Commandant F. C. Billard. "The record for the year 1926 in the primary function of the Coast Guard—the preservation of life and property from the perils of the sea—continues to show, most gratifyingly, that the law-enforcement work in connection with the prevention of the smuggling of liquor into the United States from the sea, also calling heavily and increasingly on the service forces, has in nowise been permitted to intrench upon, break down, impede, nor diminish what is undoubtedly the highest form of service it is the duty of the Coast Guard to perform."

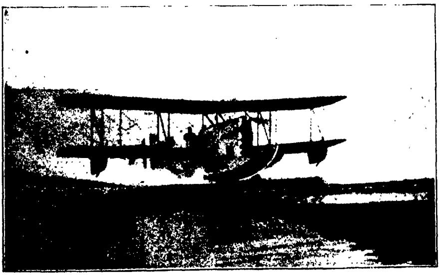
LANDING A RESCUED SEAMAN

Although a radically new method of carrying out a life-line is employed, rescued persons are still brought to land by means of the time-honored "breeches-buoy"

COMMANDER YEANDLE'S statement is backed up by the annual report of the United States Coast Guard, which shows that last year alone, 3037 persons were rescued from peril—a higher number than any year since the organization of the present service—in 1915.

Some 4831 instances of assistance were rendered during the year; 2240 of these cases involved saving of life or property or both—termed major assistance. The remainder of this stupendous figure represented such services as warning vessels standing into danger; furnishing food, fuel, and water to vessels in distress; succoring the shipwrecked; rendering medical and surgical aid to the sick and injured; assisting at neighborhood fires and fires occurring at buildings, wharves, and other structures on the shore line; fighting forest fires; assisting at floods and other calamitous visitations; dragging the waters for bodies; burial of bodies cast up by the sea; sheltering wayfarers overtaken by storm or other misfortune; preventing theft and invasion by those maliciously inclined; protecting wrecked property; acting as pilots in cases of emergency; co-operating in the enforcement of the Federal laws; et cetera.

After bringing in the unfortunate who has floundered in the waters, the duties of the Coast Guard are by no means at an end. Frequently the life-saving crews are called upon to undertake the restoration of persons taken from the water in a helpless or an unconscious condition. Out of 56 cases of resuscitation attempted by the service crews during the year, 25 were successful, the persons being restored to consciousness, and of these 25, at least five were apparently dead when they were taken in charge by the crews from the life-saving stations.



THE AIRPLANE RETURNS

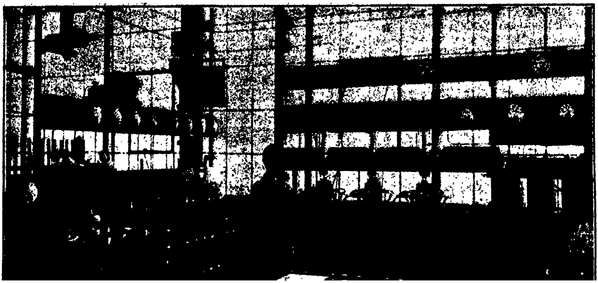
Here is shown the type of seaplane that is employed for the purpose of carrying life-lines. It is riding up on its landing platform under its own power

The station crew of the Coast Guard is divided into regular watches of two men each, who, during the hours from sunset to sunrise patrol the beach, keeping a sharp lookout seaward at all times. The schedule of watch is: First watch, sunset to 8 P.M.; second watch, 8 P.M. to midnight; third watch, midnight to 4 A.M.; fourth watch, 4 A.M. to sunrise. While the patrolman is out, his watch-mate takes the station watch, which is kept in the tower or on the beach abreast of the station, as conditions may require. If the station is connected with the service telephone line, the station watch makes it his business to be within hearing distance of the bell at regular intervals. In addition to keeping watch seaward, he is on the lookout for signals and telephone calls from the patrolman.

EACH patrolman carries a number of red Coston signals with which warn a vessel standing too close inshore or to notify a vessel in distress that he has gone to summon assistance.

A quite complete system of communication has aided greatly in the work of the Coast Guard. With radio at their service, it is now possible for ships in distress to inform shore stations of their plight, and by means of radio and wire telegraph systems on land, the nearest life-saving station to the scene of the disaster can be reached. These fast means of communication have robbed the hungry ocean of many of its terrors.

And the time has now arrived when the master of a disabled ship may look forward to assistance and rescue by means of a life-line thrown from that messenger of progress and annihilator of distance—the airplane.



WHERE THE MODULATION IS ACCOMPLISHED

In this photograph is illustrated the apparatus and the tubes that comprise the modulation section of the transmitter. From this point the fluctuating sound currents are sent to the high-power oscillator vacuum tubes which generate the radio carrier wave

The Giant of Broadcasting

Powerful Transmitter With Many New Features Wins Approval of Radio Listeners

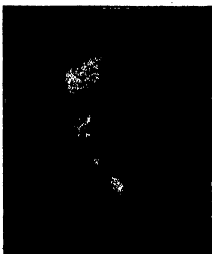
By ORRIN E. DUNLAP, Jr.

RADIO records are being shattered by the most powerful broadcaster in the world, nestled in the Mohawk Valley midst the foothills of the Adirondacks. This stentor of the ether is now hurling broadcasts into the emptiness of space with a force of 100 kilowatts or 100,000 watts, sanctioned by the Federal Radio Commission. It was only a few years ago that 500 watts represented a powerful transmitter.

The giant introduces numerous features new to the science of radio broadcasting, including five of the 100-kilowatt tubes that have made possible this advance in ethereal communication. So powerful is the installation that 60 gallons of water per minute are required to cool the tubes of the transmitter, lest they melt. A tiny quartz wafer keeps the powerful wave from wandering off its assigned channel, while automatic protective devices shut off the power in case of tube failure and warning is given should the water supply fail. The initial test is recorded in radio history as the first time that 100 kilowatts of power were modulated and put on the aerial for broadcast service.

THE transmitter is located on a 54-acre plot at South Schenectady [illegible] ing requirements for a large number of transmitters operating simultaneously on a wide variety of wavelengths. On this radio reservation there are four steel aerial towers, three of which run aloft for 300 feet and another 150 feet high. In addition there are a large number of shorter masts. There is a rectifier capable of supplying 750 kilowatts of direct current at 15,000 volts.

The development of this installation was hastened by the production of the 100-kilowatt power tube by the research department of the General Electric Company. The new transmitter occupies less than half the space taken by the 50-kilowatt apparatus, heretofore the highest powered equipment. Two of the 100-kilowatt tubes are utilized in the amplifier unit, and three others function in the modulator unit. The 50-kilowatt transmitter, operated at 30 kilowatts, in accordance with the Federal license, uses seven 20-kilowatt tubes in the amplifier and 12 tubes of the same size for modulators.



MARTIN P. RICE

Mr. Rice is director of broadcasting for the

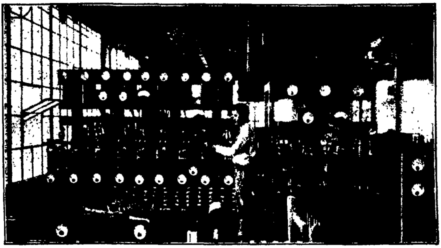
THE 100-kilowatt transmitter consists essentially of a radio power-amplifier, the frequency of which is controlled by a quartz crystal, and a modulator bank together with other necessary apparatus. Two 100-kilowatt tubes of the conventional metal-anode construction are employed in the power-amplifier unit. The anode, is copper, approximately three feet long by three and one-quarter inches in diameter. The filament and grid leads are brought out through the top of a glass cylinder which is about 19 inches long by five inches in diameter. The tube is 50 inches long.

For filament excitation the tube requires 210 amperes at 35 volts. Two of

aerial by means of coupling coils and a transmission line.

The aerial is of the vertical type, consisting of a cage two feet in diameter and 240 feet high. The wires are combined to form a single conductor for the lower part of the aerial. A counterpoise, consisting of a radial wire system 240 feet in diameter, is employed instead of a ground connection.

The frequency of the transmitter is controlled by a quartz crystal so that the powerful waves do not get off the assigned channel. The output of the crystal is amplified by five stages of radio-frequency amplification to a power sufficient to completely excite the grids of the 100-kilowatt tubes in the power stage. All amplifier stages are completely neutralized so that there is little possibility of independent oscillations in the amplifier chain. Thus the quartz crystal determines the radio or carrier frequency of the transmitter, which is 790 kilocycles, the same as used by station WGY in its regular broadcasts.



THE GIANT AT SCHENECTADY

SPEECH or music to be radiated is sent from the WGY studio over a telephone line, at a power approximately equal to that used for ordinary telephone conversations. This voltage is then amplified 1000 times by an audio-frequency amplifier chain, the last stage of which utilizes a 20-kilowatt water-cooled tube. It is then impressed on the grids of three 100-kilowatt tubes used as modulators. These tubes function directly in the plate circuit of the power-amplifier tubes and vary the plate potential in accordance with the speech frequency which actuates the microphone.

Power for the plate circuit of the transmitter is obtained from a rectifier which employs six vacuum tubes of the two-element type. These tubes are of the same size as those employed in the transmitter but have no grid structure. This rectifier is capable of supplying 750 kilowatts of direct current at 15,000 volts. Several large filter units eliminate all objectionable 60-cycle ripple from the output. Power for the rectifier is taken directly from the 13,200 volt, three-phase supply for the station. A motor-operated voltage regulator enables the operator to vary the output voltage at will, under load. So efficient is this rectifier that it is capable of supplying a transmitter having an output of 250 kilowatts. Although such a transmitter is not available at the present time for broadcasting purposes, it is considered to be practical.

RADIO STRIDES ONWARD

The new high-power transmitter at WGY established a new record when 100 kilowatts were successfully modulated. One of the big tubes is a spare

IN order to keep the anodes of the large tubes properly cooled, it is necessary to circulate 12 gallons of water per minute through the water jacket in which each tube is mounted. For the transmitter proper, exclusive of the rectifier, a flow of 60 gallons of water per minute is required. This is obtained from a centrifugal pump which obtains its supply from a cistern of 20,000 gallons capacity. On its return from the tubes, the water flows through a radiator in which it is cooled by a current of air supplied by a large blower. The water is then returned to the reservoir. This type of cooling method is termed a closed system because it is not dependent upon an actual contact between the water and air for removing the heat from the water. The water is protected from dust and other impurities so that it may be used for long periods without replenishment.

The engineers call attention to the interesting fact that the cooling water actually comes in contact with the plates of the tubes, which are at high radio and direct-current potential. It is well known that pure water is a fairly good insulator. By using a long rubber hose between the water connection to the tube jacket and the supply pipe it is possible to secure sufficiently high resistance in the column of water to prevent excessive loss of power caused by conductance of the water.

Remote-controlled electrical apparatus and protective devices make the operation of the giant transmitter quite simple. The operator has before him two major controls. One switch regulates a small rectifier which supplies the plate circuit of a small metal tube designed to supply the excitation for the main power-amplifier. A second switch controls the large rectifier which supplies the plate circuit of the main radio power-amplifier tubes and the plate circuit of the modulators. In preparing the installation to go on the air, all motor-generator equipment, including the water-cooling system and blowers, rectifiers and low-power amplifiers both audio and radio, are started. The set is finally put on the air by the use of two major control switches which, at the will of the operator, send 100 kilowatts of radio-frequency energy into the aerial. The operator constantly checks the degree of modulation by means of an oscillograph while the quality of the broadcasts is checked by a loudspeaker.

PRELIMINARY test programs have brought an unexpected volume of letters and telegraphic reports from radio auditors. The engineers are especially pleased with the unanimous endorsement of the high power and the enthusiastic applause for the tonal quality and volume of the signal as well as the sharpness of tuning.

An analysis of the letters received at the conclusion of early morning tests

indicates that the signal strength over the area east of the Mississippi River and north of North Carolina is equal to that of broadcasters operating

THE BIG TUBE

This is the type of vacuum tube that hastened the development of super-power broadcasting. Note the water jacket

within 50 miles of the receiver. In midsummer, the high-power installation was heard with good volume and clarity in parts of the country not reached by the regular 30-kilowatt transmitter after spring arrived. Listeners reported that the signal strength is so great that static, even during severe electrical storms, was completely over-ridden and the broadcasts could be appreciated for the musical quality. Many of the more distant auditors reported that fading was less frequent and less pronounced but the letters indicated that fading is not appreciably improved by high power within a radius of 300 miles, where WGY's normal transmissions wax and wane. The observers said that modulation is excellent and the quality of the reproduced signal above the average.

There is no doubt in the minds of the station officials who made a survey of the mail that the 100-kilowatt signal tunes sharply. Those with sensitive receivers were able in many cases to tune out WGY and tune in more distant stations whose frequency was separated only 20 kilocycles from WGY's frequency.

ONLY one correspondent pronounced the test a failure. This resident of Newburyport, Massachusetts, said, "There never was a high-power station that was not a failure. You cannot expect a balloon to keep from bursting when you give it too much gas. What becomes of a radio wave if blown apart?"

The president of a radio set manufacturing company said, "Modulation, we believe, was perfect; sharpness of tone both in voice and music was extremely fine. As far as we could make out by ear, this was the clearest and in every respect the best broadcast which we have ever had the pleasure of tuning-in."

A prominent engineer of the radio division of the Department of Commerce summarized a technical report on reception as follows: "It is my opinion that the efficiency of your station so far as the delivery of reliable signals to broadcast listeners is concerned, has been increased 100 percent. This holds for coverage and for quality."

A listener in Virginia reported that lightning was so severe that the street lights in parts of the city were out of commission, but that the storm had no effect upon the music radiated from the 100-kilowatt transmitter. A Pennsylvanian said that he disconnected the aerial and ground and then tuned in the signals as strong as those of a Chicago station, which he had tuned in a few minutes earlier with "everything I had."

FROM Wisconsin came the message that "WGY came in so loud that we were able to tune all the static out and get the music as clear as a bell." A listener in Minnesota said, "This is the first time that I have had any eastern station since last spring," while another report from that region said, "Your volume exceeded that of a station 80 miles away. There was no fading. Tonal quality was good and the signals tuned sharply."

The new station is apparently an enemy of static. "An observer in Arkansas said, "Although we had a lot of static, WGY was so strong that it knocked the static out completely." A Wisconsin man said, "I was about to tune off my set because of nerve-wracking static but I came across WGY with a signal so clear that static was hardly noticeable and I had to reduce the volume."

A St. Louis enthusiast reported, "Best program I have ever had on my set from any station close or far, cold weather or hot."

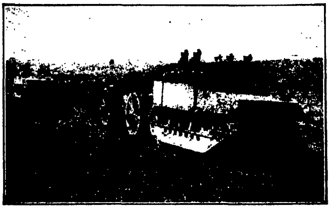
IT is expected that the WGY transmitter will be "King of the Air" as far as power output is concerned for some time to come. High-power broadcasting installations are expensive. The cost of WEAF's 50-kilowatt outfit is placed at half a million dollars. This does not include the thousands of dollars spent in the development work at South Schenectady before the transmitter was built for installation on Long Island. There are not many broadcasters in the field today who can afford to spend 500,000 dollars on an installation which within five or ten years may be ready for the archives of the past.

Nevertheless, high power insures improved public service and tends for fewer stations, both of which are sorely needed in the broadcasting realm of the United States at the present time. Perhaps some day the research engineers will learn how to successfully modulate a short-wave station with an output of 100 or 500 kilowatts and such a station might go a long way in serving the wants of the world as far as reliable reception is concerned. There is no doubt that progress in broadcasting will depend a great deal upon high power. That is why the Federal Radio Commission is beginning to look with favor upon this type of transmission.

THE TRANSMITTER AT WJZ

A section of the Bound Brook installation. Note the difference in this outfit compared with WGY's equipment. WJZ is now rated at a power output of 50 kilowatts

All photographs by P and A



READY FOR ACTION

Armored cars hauling gun carriages, taking the place of horses. The men of the crew are equipped with gas masks

THE OLD AND THE NEW

Several of the newly developed British mechanical "horses" passing in review before an obsolete horse-drawn battery

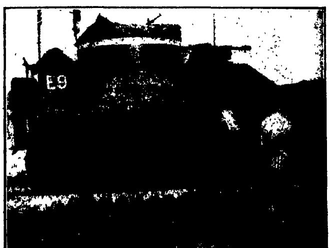
IT is a far cry from the lumbering, slow, clumsy tanks that were first used in about the middle of the World War, and which were used with such telling effect, especially on the morale of the enemy, to the present-day mechanical vehicles that are a part of every modern army.

Especially is this true when the present variety of tanks is considered. They range in size from tiny "tankettes" to full size vehicles and they carry armament consisting of pieces varying from machine guns to field artillery. And no longer are tanks limited to fighting—they now take the place of horses in many phases of warfare, and they fill the requirements to much greater satisfaction. While they have their own peculiar troubles, they are found to be more efficient in many ways than horses.

THEY are employed for transporting troops and also for towing units of artillery into the battle lines. In recent war maneuvers held in England, the "British Mechanised Army" as the highly developed tank corps has been termed, demonstrated its superiority over the horse. In a series of tests, the caterpillar equipped transport vehicles developed speeds of up to 35 miles per hour, thus showing that by their use, the movements of troops, supplies and artillery can be speeded up to a great extent.

As we have illustrated on our cover this month, radio is often a part of the tank equipment. By the use of this communication system, the various units of a corps can be kept in constant touch with each other and thus always in co-ordination. Directions can also be obtained by radio.

THROUGH THE MUD



"CURRYING" A MECHANICAL STEED

How Nature Conquers

When One Watches Closely the Reforestation of a Barren Area, Some Surprising Routines of Nature are Revealed

By H. J. LUTZ

Formerly Technical Assistant, United States Forest Service; Member, Society of American Foresters; Ecological Society of America

What is "Ecology?"

ONE of the most interesting corners of science is that of ecology, "the science of the relations of the organism to environing conditions, organic and inorganic." When we start out, as in the accompanying article, to see whether there is any system in Nature's rehabilitation of a waste area, we discover that, apparently, system permeates it all. But is this a purposive system? The evidence, killing romance, says "No." Natural forces—fortuitous circumstances, cause and effect, survival of the fittest—these alone, and not a conscious Nature, control it.

The Editor

NOT so many years ago, as geologists figure time, vast portions of southwestern Alaska were locked securely beneath great sheets of ice. It is only in comparatively recent times that these immense blankets have shrunk to the remnants we see today. By referring to the present day ice-fields as "remnants" it is not, however, intended to imply that they are insignificant, for they certainly are not. Yet they do represent only the skeletons of the far more extensive fields which existed in past ages.

As the ice of a glacier melts back, year after year, it deposits in front of it extensive moraines of glacial debris. These, of course, are at first totally devoid of plant life. Besides these barren moraines there are the bare rocky flanks of the valley which are often polished smooth, with all loose rock and soil swept away. These uninhabited areas are new worlds for Nature to conquer. She is challenged to the work of reclaiming these barren fields, a truly great task, yet one of which she has many times proved herself fully capable.

As glaciers of the present day recede, an excellent opportunity is afforded to see just how Nature regenerates such areas; how she musters her forces, and under just what conditions she wages her battle.

AS a glacier retreats—that is, melts back, for no glacier ever actually moves bodily backward—it drops its burden of rock flour, gravel, and other debris that it has carried so far in its icy grasp. The raw, rocky soil, totally devoid of any organic matter, and practically sterile as to bacterial life, presents a cold, inhospitable place for any plant growth. Moreover, the newly formed land features are not stable, and continual slumping and rapid erosion take place. Besides these adverse conditions, blighting winds sweep down off the ice with terrific force. In places these winds alone are so severe as to prevent any arboreal growth.

However, Nature, with all her fortitude, has developed plants which can exist, yes, even thrive, under just such conditions. One may well expect the earliest invaders on these frontiers to be sturdy pioneers that gain and hold a place for themselves in the face of great odds. One can also expect these first plants to be herbaceous perennials, for such plants have an immense advantage over the trees because they are smaller of stature and spend the winter in a dormant, or nearly dormant, state. Then, too, even if these small plants do suffer heavily from frost or other injury they can soon regain any ground they lose, since they are such prolific seeders, multiplying rapidly.

THE FIRST STAGE OF REHABILITATION

For a long time the rocky flanks will support only little particles of moss or at most, scattered shrubs

On the other hand, the trees may live and thrive for many years and then fall the victim of one exceptional season and, due to their relatively more scanty and less frequent seed production, they may find re-establishment more difficult and slow.

The first plant which is found to come in after a glacier has done its devastating work is a small brown moss that seems to possess unusual hardiness for so diminutive a plant. It grows here and there in little patches over the rock-strewn moraine, even within a couple of hundred feet from

THE SECOND STAGE OF REHABILITATION

A patch of lupine has become established on an otherwise sombre landscape, forming a close, compact community of small plants

A TYPICAL OUTWARD MORAINE

The broad flat is composed of glacial debris. It is too unstable to support very much vegetation, except in small patches here and there

A CASE OF GENUINE FRIENDSHIP

THE FOREST VANGUARD APPROACHES

the ice front. Since the yellowish brown patches blend in with the drab color of the ground, one does not at once sense the importance of these little plants. However, they are an essential part of Nature's plan for colonization, preparing as they do, the way for the succeeding stages of plant life.

This moss is soon followed by a somewhat higher step in the scale of development, characterized by a beautiful, showy lupine. The lupine grows luxuriantly, and forms dense patches which would rival the beauty of any cultivated flower garden. Each of the long stalks bears great numbers of dark, purplish red flowers, making royal splashes of color on the otherwise somber landscape. I have noticed single stalks with over 130 seed pods, each pod containing from eight to nine seeds. Since single plants commonly have 50 to 60 stalks, the tremendous seeding ability of this plant becomes at once apparent.

When the lupine has stabilized the fresh, raw soil, and has added organic matter, we find that it, too, is replaced by a third and still higher stage of plant growth. It is at this point that willow, alder, and black cottonwood seedlings make their appearance, along with scattered invaders of Sitka spruce and hemlock. The spruce and hemlock seedlings, especially, show unmistakable evidence of their severe battle with the elements.

CONQUEST OF THE CONIFERS

The spruce and hemlocks have over-topped the alders and willows, and conquered

They cling close to the ground, forming grotesque little figures here and there, or else they seek shelter from the terrible winds behind mounds of earth, or kindly rocks—anything, in fact, which offers protection.

The constant gales which sweep down off the glaciers greatly retard the establishment and advance of plant life in these new places. So severe are these winds that the upper slopes facing the ice front, as well as the ridge tops, are often totally devoid of any growth. Since the leeward slopes are not so much affected by these winds, they support a luxuriant growth of vegetation when the exposed slopes are still quite bare. This difference in rate of advance results in a distinct zonation of the vegetation.

THE uneven battle these trees wage with the elements renders their growth unbelievably slow. Little spruce trees four inches high often show ages of 40 to 50 years. Instead of appearing as normal trees, many of them are low, almost prostrate, bushes.

Some of the trees in exposed places show the severe scouring effect of wind-driven snow and have their bark eaten away and smoothed by it on the windward side, leaving long patches of dead wood exposed. In one place the writer was astonished to find trees 12 inches or more in diameter which had been snapped off by the wind as though they were straws.

This damage goes on each year, but as the trees are injured they rally and try to send out a new leader which in time may become the main trunk. Sometimes several new leaders start at the same time and thus the tree takes on a dwarfed, bushy appearance, becoming "bayonet-topped."

Sooner or later, due to their longer life and ability to endure shade, these fourth stage invaders, the spruce and hemlock trees, are able to overtop the willows, alders, and cottonwoods, and once this is done they make much more rapid growth. Yet even when they accomplish this, the struggle between the trees for light and water continues to be just as keen as ever, and many of the poorer and less adaptable individuals are killed while they are still young. The more hardy ones continue to develop and grow and finally form a mature forest on the moraine which some 200-odd years ago was locked in the icy embrace of the glacier. Thus, fully developed

THE CLIMAX FOREST

A forest of fine large Sika spruce on a glacial flat at King's Bay. Final stage

stands of spruce and hemlock are sometimes found within 1000 feet of the ice front.

The plants represented in each stage of such a succession as the one just outlined are the best adapted ones available for the colonization at that particular time. As the plant communities become higher in the scale of development they become more complex, and competition increases until it finally becomes so keen that only the fittest are able to survive.

Because of this survival of the fittest, working over long periods of time, there are few imperfections in Nature's final expression of vegetation—the climax forest.

The Stars of the Manger

Ten Co-operating Astronomical Observatories Have Revealed that the Little Cluster Known as Praesepe—"The Manger"—Contains Over 350 Stars Traveling Side by Side Through Interstellar Space

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mt. Wilson Observatory of the Carnegie Institution of Washington

THE astronomers of antiquity were remarkably good observers; there is very little in the heavens which the unaided eye can see well enough for real study which they did not note.

In the constellation "Cancer," for example, among its rather inconspicuous stars there appears a little diffuse patch of light which is easy to see only on a clear, dark night, but under good conditions is always found to be there, a permanent feature of the heavens. They called it in Roman days "Praesepe"—the manger, while two little stars nearby were the "Aselli," the donkeys who fed upon its contents.

"Praesepe" is in the heavens still, in the same old place, and it looks to the eye the same as ever. But, even an opera glass shows what it really is—a cluster of stars of which the brightest are just too faint to be visible separately without optical aid. Were any one of them by itself we could not detect it at all without such assistance; but there are so many of these faint stars within a small area that their combined light is about a quarter that of the Pole-star. Though we cannot see the separate stars the cluster appears therefore as a hazy spot of light.

THE brighter of these telescopic stars have long ago been carefully observed and catalogued, and a century's observations show that they are moving in the heavens, and as might be expected, moving together toward the east and south at the rate of one degree in 100,000 years. Slow as this motion is, the observations suffice to define its amount pretty accurately, and to detect with certainty the few stars which do not belong to this cluster, but lie in line with it and in front or behind. The chance that such an unrelated star should happen to be moving in the same direction as the cluster and at apparently the same rate is obviously very small. All other interlopers can be picked out at once by their discordant motions.

These proper-motion observations, however, are limited to a dozen or so of the brightest stars of the group. To search for fainter ones recourse may best be had to photography. An interesting investigation by this means has recently been made by Dr. Klein Wassink of the Kapteyn Laboratory at Groningen, Holland, which now bears the name of its founder and first director.

To determine such small motions with certainty it is necessary to compare plates taken many years ago with recent ones. By the friendly co-operation of several observatories at which photographs of "Praesepe" had been made in past years new plates were taken and both old and new ones sent to Groningen to be measured. How thoroughly international the study of the heavens is, is well illustrated by the list of the co-operating observatories: Pulkavo in Russia; Greenwich and the Radcliffe Observatory (at Oxford) in England; Stockholm in Sweden; Helsingfors in Finland; Potsdam in Germany, and the Lick, Yerkes, Allegheny and Dearborn Observatories in this country—ten institutions in all, belonging to six different nations. The intervals in date between the earlier and later plates range from nine to 82 years—long enough to disclose the motion clearly.

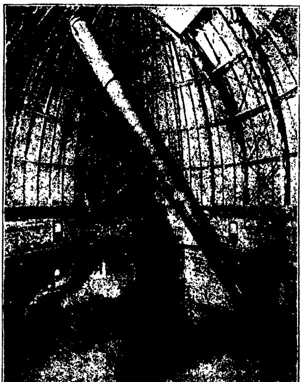


Photo by Yerkes Observatory

THE YERKES REFRACTOR

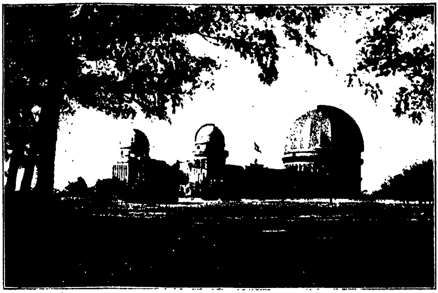
The main instrument of the Yerkes Observatory is a refracting telescope having an objective lens forty inches in clear aperture

Upon these various plates the images of about 600 stars were measured and their motions found. The list is fairly complete as far as the thirteenth magnitude; and the Lick plates, though covering but a small part of the whole cluster, go down very much further—to the eighteenth.

WHEN the results had been collected and the various sources of error eliminated (a tedious job) it appeared that the majority of the 600 stars were standing nearly still in the sky or at least moving slowly in all directions at the rate of perhaps a quarter or a half a degree in 100,000 years. Nearly 200 of them, however, were moving faster—a whole degree during the same period, and substantially all of these were going at the same rate and in the same direction. These latter stars and these alone are evidently the real members of the cluster. The rest, as their small motions show, are mainly "background" stars, far behind the cluster.

All told—and making allowance for the fact that the cluster appears to extend in some directions over a larger area of the sky than the plates cover—it appears that there are in

the "Praesepe" group about 80 stars brighter than the tenth magnitude, as many more between the tenth and twelfth, and about as many again between the twelfth and fourteenth. The number of fainter stars is harder to estimate, but it is probable that the whole number down to the eighteenth magnitude is about 358. These stars are scattered over an area of the sky about four degrees in diameter—though the brighter ones which form the group visible to the naked eye are confined within a radius half as great.



THE YERKES OBSERVATORY

SUCH a group of related stars, which we cannot doubt to be of common origin, invite further study. The spectra, for example, of many of the stars have been observed and the same situation is found that exists in many other clusters. Among the brighter members all spectral types except "B" and "M" appear—that is, we find stars of all temperatures except the very hottest and coldest—but the fainter stars of any given brightness are much more similar in color, and on the average are redder, the fainter they are. Here we evidently have the familiar giants and dwarfs, and it is clear that the brightest stars of the cluster must be comparable in reality with the brightest in the "Hyades" cluster (in which a similar situation is found), while those of the eleventh magnitude, which are dwarfs, not far from the solar type spectrally, are doubtless comparable also with the sun in brightness.

If this is true we know both how bright these stars look and how bright they really are, and from the comparison can find their distance, which comes out a little less than four times that of the "Hyades." Dr. Klein Wassink, from all the available data, derives for the "Praesepe" a parallax of 0".0073, or a distance of 450 light-years (while that of the "Hyades" is 120 light-years). With the distance known, it is found that the bright, central part of the cluster is some ten light-years in diameter—though, of course, no exact limit can be set for so ill-defined a boundary—while the outer stragglers extend through a region more than 30 light-years across. The cluster is therefore very similar in size, as well as in the brightness of its members, to the "Hyades," the difference in appearance of the two to the eye arising from the difference of their distances. The brightest individual stars in "Praesepe" give out from 30 to 50 times as much light as the sun. There are about 100 in the cluster which are brighter than the sun, and some 20 of these are ten times brighter. The faintest stars which have been found in the cluster must be but feebly luminous—of about the twelfth absolute magnitude and hardly more than one-thousandth as bright as the sun.

Knowing the distance of the cluster, its apparent motion in the sky, and also its radial velocity—which spectroscopic observation give us—it is easy to calculate how fast it is really moving, and toward what direction in space. A remarkable situation then appears—"Praesepe" and the "Hyades" are moving in almost the same direction in space, and at nearly the same rate. As calculated from the data here reported the two lines of motion are inclined but five degrees to one another, and the velocities of motion, referred to the sun, are 41 and 44 kilometers per second. These discrepancies are hardly greater than the uncertainties still remaining in the calculated values, and it appears quite probable that these two great systems are really moving together in space along parallel lines and are truly twin clusters, not alone in size, brightness and motion, but in origin. What that origin may have been we can hardly yet even conjecture, nor is so close a community between the two a matter of certainty. But the evidence in its favor is very impressive.

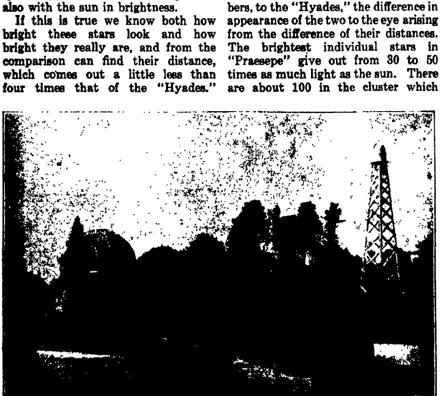


Photo by Mt. Wilson Observatory

TELESCOPES AT MT. WILSON OBSERVATORY

ny and varied astronomical instruments are in constant use at Mt. Wilson. Here the two r telescopes for solar observations and the massive dome of the 60-inch reflector are shown

WHEN next we look, then, at this shining spot in the winter skies, we may perhaps realize, as we may not have done before, how much that is wonderful, even in our sophisticated age, is revealed by painstaking study of a relatively inconspicuous object which at first glance appears but as a shred of luminous haze.

From the Scrap-book of Science

Herbert Photos

TOKYO—FOUR YEARS AGO

On September 1, 1923, a fire following a tremendous earthquake, nearly wiped out the city of Tokyo. The total loss amounted to more than a billion dollars and was felt by all Japan. Picture shows ruins of the Azuma Bridge

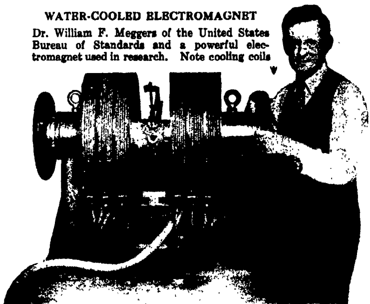
TOKYO—AT THE PRESENT TIME

Today the same bridge has been replaced and the city rebuilt, as might have been predicted by anyone knowing the resourcefulness of the Japanese people. New office buildings are designed for withstanding earthquake shocks

SLOW-MOTION CAMERA

Inventor C. Francis Jenkins, of Washington, D. C., and his newest invention—a camera that takes slow-motion pictures of automobile engines

P and A Photo



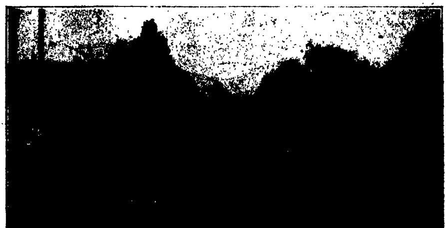
WATER-COOLED ELECTROMAGNET

Dr. William F. Meggers of the United States Bureau of Standards and a powerful electromagnet used in research. Note cooling coils

Underwood and Underwood

OCEAN TEMPERATURE

Steamships are being equipped with automatic thermographs for recording the temperature of the waters of the sea. This instrument, adopted by the University of California, replaces the old bucket tester which recorded only surface temperatures



Herbert Photos

NOT A TUG-OF-WAR

Here is an odd sight recently noted in Los Angeles where the people, accustomed to seeing motion-picture troupes at work, are not surprised at anything. A 25-ton steel girder, too long for one truckload, had to be moved 12 miles. A second truck was assigned to one end of the job—and was driven backward the entire 12 miles! Thus was the heavy, awkward load satisfactorily distributed

Camera Shots of Scientific Events

P and A Photo

SCENE AT THE FAMOUS LAKEHURST, NEW JERSEY, AIRPORT

In the air at the extreme left of this unusual panoramic photograph is the Army blimp J-3. Moored to the ground is a dirigible, and to the head of its mooring mast at the right in the picture is the huge well-known *Los Angeles*

International News Reel

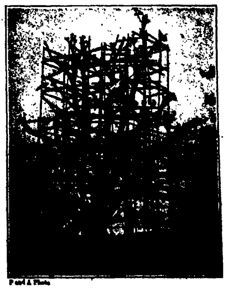
P and A Photo

WHAT IS RAMIE FIBER?

It is a perennial plant which once furnished clothes for Egyptian kings. George W. Wilson predicts its come-back

LOFTY DAM

Looking up and down on the Pacioma Canyon Dam in the mountains above San Fernando, California. It has just been erected at a cost of over two million dollars, after two years of work. It is one of a series of engineering projects intended to protect the fertile and prosperous San Fernando Valley against floods due to mountain cloudbursts. Its extreme height is 383 feet and it is 600 feet wide across the top. At the base the thickness of the dam is said to be one hundred feet; this tapers toward the top where the edge is only eight feet thick

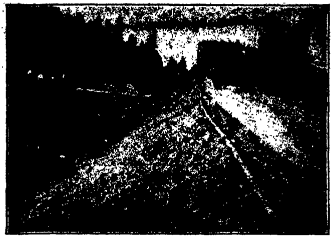


P and A Photo

MAMMOTH GRAFT

This enormous black walnut tree will hereafter produce English walnuts

NEW TYPE OF DRAG-LINE



SHAPING THE CANAL BED

Water—the Modern Aladdin

Thousands of Acres That Are Now Useless for Agriculture, Will be Made Available for Crop Production by the Opening of the Completed Kittitas Irrigation Project

By CHARLES F. A. MANN

AFTER nearly 40 years of patient effort by citizens of the Kittitas Valley in central eastern Washington, work on the new Kittitas High Line Canal is now under full headway and by 1929 the waters of the Yakima River will be pouring into the Kittitas Valley and will bring some 72,000 acres of almost worthless sagebrush land under intense cultivation. The Kittitas Valley is by far the most economical unit to develop of the entire series of projects in the Yakima Valley and is located on the northern end of one of the most fertile valleys in the United States.

Just east of the center line of the Cascade Mountains three beautiful lakes, Kachess, Keechlus and Cle Elum lie nestled in parallel form in the heart of the Cascades. From their outlets run small rivers which join a few miles away in the valley below and form the headwaters of the Yakima River.

FOR 150 miles this river wends its way through a valley filled with a deep layer of black decomposed volcanic ash and basalt, and travels southeastward in the form of a gigantic figure "S" to the Columbia River at Pasco, near the lower end of the great Columbia Basin. Conditions for growing the finest of crops in the world are perfect here but for the lack of sufficient moisture during July and August.

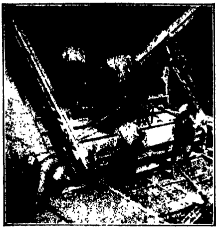
Few sections of the world are as interesting climatically as the State of Washington. On the western slope of the Olympic Mountains near the seacoast the rainfall averages over 130 inches per year. About 40 miles further inland on the Puget Sound Basin the rainfall averages about 40 inches and on the slopes of the Cascades the heaviest snowfalls in the world are recorded, with a seasonal average running well over 100 feet. A few miles eastward from the lower slopes of the Cascades the rainfall drops back to about nine or ten inches and in the great Columbia Basin, which stretches for 200 miles from the Canadian line to Oregon, the rainfall is scarcely eight inches. The average rainfall of the Yakima Valley is about nine inches and entirely insufficient for continuous crops. In fact there is such a wide variation of climate that it is impossible to even find a state flower that will grow in both sections of the state.

THE CONCRETE LINING

A special movable steel form, the exact shape of the canal, holds the concrete

In western Washington there is found the densest belt of timber on the American Continent and vegetation is literally drowned with water. The farmer's principal problem is getting his rainfall evenly distributed throughout the year. In the eastern part of the state the problem is getting any water at all on the crops. The soil conditions in the east section are far better than in the west on account of the excessive rock and gravel deposits and irregular land everywhere but in the river valleys, which mark the Puget Sound Basin. Therefore the great problem of the people of eastern Washington is to put more water and then more on this soil and hence the beginning of the great cry for water as early as 1880. There are over 3,200,000 acres of land suitable for irrigation in Washington, of which 1,800,000 are in one solid mass in the Columbia Basin.

WHEN the first government project along the lower Yakima Valley was undertaken in 1908 the Kittitas division of the same project was the next to be completed. A few settlers first caught the vision of an agricultural empire in 1889 and later



PLACING THE CONCRETE

Another view of the lining, showing how the sides and bottom are laid and held

formed the Yakima, Kittitas and Northern Pacific Irrigation Co., to finance the irrigation of the Kittitas Valley. But through influence of residents of Yakima, the Tieton and Sunnyside divisions of the project were built first, and later the Wapato division by the Indian Service for the Yakima Indians, and within a few years the famous Yakima apple began to appear in the world's markets. The total annual crop raised by the three completed divisions of the Yakima project amounts to about fifty million dollars and is raised on about 250,000 acres of land.

In all there are seven divisions of the project, the Sunnyside, Tieton, Roza, Wapato, Moxee, Kennewick, and the Kittitas Basin in the northern end of the valley. There are twelve present and proposed storage reservoirs projected and in operation, all except three being inside the Ranier and the Snoqualmie and Columbia National forests. The total area watered by these divisions when finished will be about 475,000 acres with an annual crop of well over 100,000,000 dollars.

On these projects some 30,000,000 dollars have been spent of private and government money. The most famous of all these projects is the Kittitas division, located in the Kittitas Valley near the base of the east slope of the Cascades and about 130 miles from Seattle and Tacoma. The soil in the valley is fertile and the climate more equable than that found in any other division.

In the center of the valley is located the town of Ellensburg with a population of about 4000 and is the home of the State Normal school as well as the division point of the railroads. Water was first run on sections of this valley near Ellensburg many years ago and as early as 1910 surveys were first run out for a long canal from near the headwaters of the Yakima to bring water into the higher sections of the valley. The entire district was organized as a corporate body in 1911 and empowered to make contracts and settle the land.

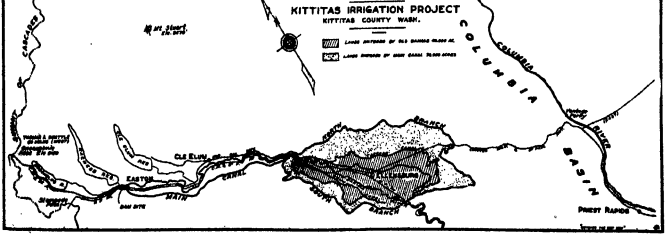
CONTRACTS for the sale of five millions of bonds were ready to sign for the purpose of financing the project in 1915 and hopes of completing the project by 1916 were high. A slump in the bond market caused by rumors of war caused the project to be dropped and it was not until 1923 that the government resurveyed the project and announced that work would be resumed. In 1925 the necessary sum of money for the construction of the first half of the main canal from the river at Easton to the head of the main valley was appropriated by Congress and in December 1925 the first contracts were let.

Actual construction on the main canal known as the Kittitas High Line Canal, began in the fall of 1926 and it was not until the summer of 1927 that any progress had been made. The total cost will be about nine million dollars and water 72,000 acres, 12,000 acres of which are available for cultivation outside the main valley. At present there are 40,000 acres watered within the valley proper.

READY FOR THE CONCRETE

Near the headwaters of the Yakima River the three lakes have been dammed across their outlets by earthen and rock walls; Lake Kachess holding 210,000 acre feet and raised 60 feet, Lake Cle Elum will hold 400,000 acre feet when the main dam is finished, and Lake Keechlus holding 152,000 acre feet when raised 70 feet.

These three lakes hold the flood waters released from the hillsides during the spring run off and by means of special automatic flood gates release it into the river during the dry season. Lake Cle Elum will not supply water for the Kittitas Basin, however, as it empties into the river below the diversion dam at Easton. The three lakes are in operation in conjunction with the other Yakima projects further downstream, the Kittitas division paying 1,710,000 dollars for water rights as proportionate cost of the impounding works. The total amount of water will



WHERE THE BENEFIT OF THE KITTITAS IRRIGATION PROJECT WILL BE FELT

...e map details the location of the various canals of the Kit-...tem, and shows how a huge section of land will be made available for the raising of crops. The main canal and its branches will open up to the farmer a total of 70,000 acres formerly worthless

be about 300,000 acre feet per year.

About one half mile above the town of Easton a dam 250 feet long and 65 feet high will soon be built across the Yakima River and from the foot of this dam, which will raise the water 45 feet and flood about 275 acres, begins the main High Line Canal. This canal wends its way along a narrow shelf above the Yakima River for a distance of 26 miles and passes through the richest coal fields west of the Rocky Mountains, the famous Roslyn mines on the east side of the valley.

At a point on Thorps prairie near the northern entrance to the main valley the canal divides and two thirds of the water is carried across the Yakima canyon and two railroads in a steel syphon over 12 feet in diameter which is carried on concrete piers and nearly 6000 feet long. The other branch goes along the southern rim of the valley for about 14 miles and crosses the Yakima canyon in another syphon about six miles below the town of Ellensburg where it meets the North Branch Canal.

This North Branch Canal starts from the eastern end of the big syphon and follows the northern and eastern rim of the valley for 50 miles until it meets the South Branch Canal. Thus it completely encircles the valley which is shaped like a stomach and all lateral canals will drop gently from the rim to the floor of the valley. There will be about 90 miles of main and 450 miles of lateral canals.

THERE will be six concrete-lined tunnels on the project with a total length of two and one-fourth miles and about 20 syphons with a total length of nearly four miles, the longest being 5400 feet in length.

The main canal will have a capacity of about 1850 feet of water per second and will be a veritable river, having a total width of 45 feet at the top and 12 feet at the bottom and about 12 feet deep. Enough water will flow through the canal each season to cover Manhattan Island 40 feet deep. The canal will be lined with concrete for about half of its length and will water a large strip of land lying along each side of the canal. A canal known as the Wippel Pump Canal will be supplied by means of a series of centrifugal pumps and will be about 15 miles long and water what is known as Badger Pocket in the extreme eastern section of the valley.

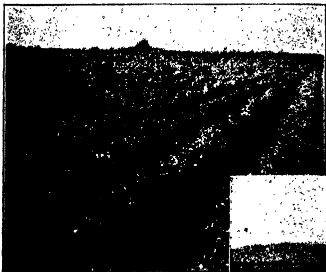
Some conception of the magnitude of this project may be gained by the fact that about eight cubic miles of earth will have to be moved in digging the canals. A typical system of digging the canals is as follows: first, the preliminary surveys were laid out and a topographical map drawn to scale of the entire project so as to assure the exact fall per mile in order to bring the water into the valley at the highest possible level; then, second, main surveys were laid and the right of way marked out.

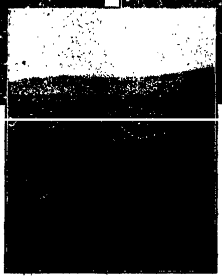
A crew of men together with a crew of county road engineers cleared the right of way and the roads were relocated. Stumps and trees were blasted and the line of the cut staked out. A one ton drag-line of a type seldom used in such work was built and hauled onto the line of the canal. This is operated by a gas engine and scoops the dirt out of the cut from the side and builds up the side walls.

A SPECIAL crew of men next follow the shovel and by means of a special liner made of steel girders molded to fit the shape of the finished canal, smooth off the sides and bottom preparatory to placing the steel matting. This is the most perfect system for measuring the correct angles of the walls yet devised. The heavy steel matting is then put in place and the concrete lining poured in place and covered with matting for curing. The unlined sections are of much larger size in order to prevent erosion.

More than 18,000,000 pounds of steel re-enforcing bars will be used in the lining or about seven trainloads. Over 250,000 cubic yards of sand and gravel will be used in the cement mixture, most of which is hauled from a distance of 135 miles from Puget Sound because of the lack of deposits of sufficient size near the project. Approximately 900 carloads of cement or about 16 trainloads will go into the canal as well as 750,000 feet of lumber. A system of laterals will reach every quarter section or 160 acres and the project will be expanded as the settlers move in.

The total cost under the government contracts with the various contracting companies on the project will bring the total charge to about 155 dollars per acre, lower than any other unit of the project. A unique fact will be that no farm will be greater than seven miles distant from a railroad and the cost will be only $1.40 per acre per year after charging off the cost of putting water on the land.





IRRIGATION RESULTS

Sage-brush land, lower center illustration, is worth about five dollars an acre, but the presence of the sage shows that the land is rich, needing only water to render it fertile for farming. The upper left-hand illustration shows similar land, after water has been on it for two years. A luxurient crop of potatoes is being raised. The upper right-hand photograph shows an alfalfa crop that was raised on irrigated soil

Successful Inventors—XII

An Industrial Expert Tells Why Manufacturers Must Seek New Inventions to Keep Their Wheels Turning

By MILTON WRIGHT

"THE inventor needs to find a manufacturer before he can make money out of his invention. But how about the manufacturer? He has a factory, a product, and a market. Does he need the inventor? If so, how can inventor and manufacturer be brought together to the profit of each?"

We put these questions, and a number of others, to John F. Sherman on one of his flying visits to the New York office of his far-flung industrial engineering organization. Sherman is not an inventor; neither does he represent inventors, but an interesting part of the work of The Sherman Corporation, of which he is president, has to do with adoption of inventions by manufacturing companies.

The quickest way to describe the Sherman organization is to call it a doctor to industries, helping healthy companies stay healthy and grow healthier, and finding for sick companies the causes of their sickness and then working out remedies.

Companies making all sorts of things from agricultural implements to watches seek Sherman's help in solving problems of declining profits, high costs, technical and mechanical procedures, markets, sales, and so on. Being concerned with what makes the industrial wheels tick and what causes them to slow up and occasionally to stop, Sherman and his staff have probed deep into fundamental causes of industrial conditions. They have found that many companies are suffering from too much plant. Back of this condition may be the fact that they have products which have become obsolete; that need improvements, refurbishing; or, they may need an entirely new product which could be made with existing equipment.

WE had heard of these activities and were prompted to get in touch with Sherman and find out what it is all about and what suggestions might ensue from the interview which would prove helpful to both inventor and manufacturer.

Therefore, to return to one of the questions at the beginning of this article—"Does the manufacturer need the inventor?"

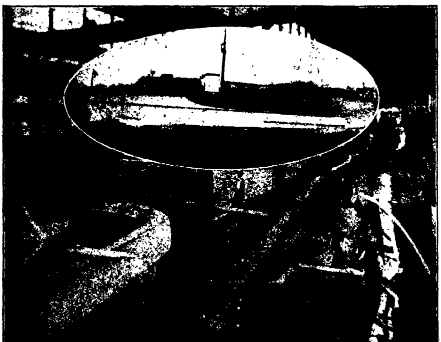
"The inventor has been responsible for much of the phenomenal progress of American industry," said Mr. Sherman, "and his importance in the development of industry in the years ahead undoubtedly will be even greater than in the past. The rubber industry, the automobile industry, the motion

JOHN F. SHERMAN

picture industry—to recall just a few typical ones—are built on the brains of inventors. And it is not alone in the building of new industries that the inventor's contributions are vital, but in keeping old-established industries from dying of dry-rot."

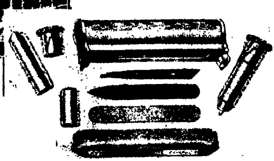
We asked why the inventor is of such importance today any more than in the past.

"Economic pressure," said Mr. Sherman. "Strenuous competition is the order of the day. As one of my associates has phrased it, 'Competition is the death of trade but the life of new ideas.' Markets today are held because the alert manufacturers who are holding them are alive to the need of new ideas and new products. This is true not only in the field of style merchandise but throughout the world of making and selling. Consumers are educated today, through advertising. They rule the roost. The manufacturer who never has anything new to offer kisses goodbye to his customers. Also remember that these problems of market are inter-related with the fact that the country's production facilities are expanded to a point where more and more volume is essential. To solve the complex problems which arise out of the new conditions of today, manufacturers need sound reductions in



A TOOL COMPANY BUILDS DE LUXE MOTORBOATS

Like manufacturers in many other lines, a nationally known manufacturer of a refillable pencil found his plant adaptable to inventions of many other kinds. He has added not only a neat manicure set to be carried in a handbag, but also a shock absorber to increase riding comfort in automobiles



unit costs of manufacture, a broadening of their markets, a one hundred percent utilization of their plant machinery and equipment."

We interrupted. "True enough, but where does the inventor fit into this picture?"

"By supplying the manufacturer with something that will keep the wheels of his factory turning. Ninety percent of American industry today is over-capacitated. During the World War the big problem was one of production, so factories were enlarged and machinery added, in a desperate effort to keep pace with unprecedented consumer demand. You could sell it if you could make it.

"IMMEDIATELY following the War we found ourselves with a world-wide market and industries were still further expanded to take care of it. Today we have no such world market as we had a few years ago, but our factories have not shrunk. Manufacturers find themselves facing these problems:

"How to utilize over-capacitation of machinery and labor, unused floor space, oversupervision and so on;

"How to level seasonal peaks and valleys by bringing together suitable products and plants equipped to manufacture them;

"How to standardize production, eliminating unnecessary parts and slow-moving items;

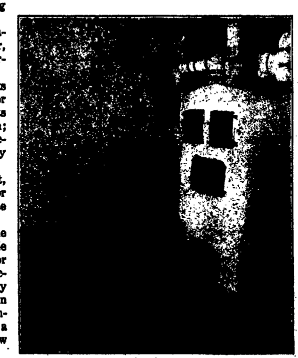
"How to stabilize employment, thereby obviating high wages for short-time work and keeping the organization intact.

"In all of these activities the inventor plays an important role by providing new products or improved methods of manufacture. The right invention may well be the determining factor in the question of whether a company will go on operating at a loss or turn the corner and show a substantial profit."

"Can you give me," we asked, "any specific examples of an invention saving the day for a factory that is overcapacitated?"

"I might say that I could give you any number of them, but I don't believe I had better answer that question, without first pointing out some other facts. Will you let me make at this time a distinction between what I will call a raw invention and a new product ready for the market?

"Our experience with inventors and with manufacturers indicates that there is a tremendous amount of inventive effort going to waste. A great deal of free-lance inventing means that the poor inventor spends a vast amount of time and thought and often hard-earned savings working up some useless gadget that nobody will have.



AXLES AND OIL BURNERS

An oil company had a burner patent. An axle factory had surplus facilities. Co-operation brought profits

"The inventor must realize that the first requisite of any new invention is that there be a possibility of broad human need underlying it, and machinery for its distribution that can be made to turn without spending a small fortune. Let him remember the really outstanding inventions and think of them not as mechanical creations but as things that made it possible for humanity to ride where it had walked; to bridge space with conversation where it formerly required days to transmit messages. Let him remember Gillette's safety razor. The money on this invention has been made not through the razor but the blades. Gillette's fundamental idea from which that invention sprung was that he wanted to get something for which there would be unlimited repeat business. His hitting upon a blade that could be used and thrown away was a stroke of real genius.

"This element of need is the thing that has been fundamental in inventions which have won commercial success. Before he spends a lot of time, therefore, let the inventor check up on the potential market.

"THE manufacturer rarely is interested in raw inventions. What he *is* interested in is something that can be made with his present machinery and for which a market exists or can be developed without too much time and money being spent. In other words, his interest is not so much in new inventions as in new products. To get back to your question, there are any number of examples of how new products have stepped into a manufacturer's picture to add greatly to his profits.

"General Motors is making electric refrigerators. A company that for years made nothing but guns is now manufacturing an electric washing machine. We found a company the other day that used to make only gunsights and correlary products. Now it is doing a big business in lamps, especially lamp bases.

"A man brought to us not long ago what he called a sedan cruiser. It was the last word in comfort afloat. From stem to stern it had a wealth of novel inventions. Everything you could think of to make cruising a pleasure was on that boat—even to an automatic cocktail shaker in the cabin. The inventor had no factory and no capital. All he had was one boat and a lot of patents.

"In another part of the country was a tool manufacturer. His factory was bigger than his mar-

ket and he needed a new product to keep his machinery and his men busy all the time. In this instance our organization brought together inventor and manufacturer. We analyzed the potential market for the cruiser. We worked with the manufacturer and helped plan for production on the new product. Today there is a lot of business booked—profitable to both tool manufacturer and inventor."

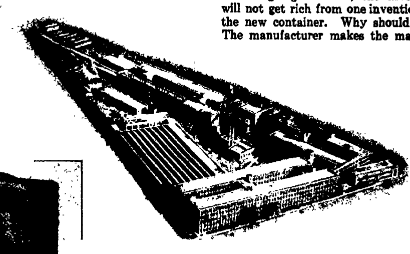
"But how could one ever arrive at the conclusion that any two persons so widely apart as a motor boat inventor and a tool manufacturer would have anything in common?"

"That, I grant you, is something that calls for a searching analysis of a manufacturer's equipment and methods as well as of a thorough understanding of just what manufacturing facilities are adequate to turn an invention into a commercial product. Many industries are peculiarly adapted to do things they never think of—things that would solve vexing industrial problems.

"Recently an inventor patented an alarm clock attachment for oil-burning furnaces. He and his backers planned a new company to manufacture the product, build a factory and set up machinery. All that, of course, meant enormous expense. One of our clients, however, had a plant that was ideally suited to the manufacture of this ticle. Furthermore, the plant was twenty percent over-capacitated. A new product to add to the line was badly needed. The oil-burner attachment was added to the line. It rounded out his production and added materially to his profits, not merely on paper, but in actual dollars and cents. The inventor and his backers are delighted, for they get their product manufactured in a plant which is in a position to do the work economically. They also are receiving material help from the manufacturer's sales organization.

"CO-OPERATION is helpful not only between the manufacturer and the inventor, but among various manufacturers. A number of manufacturers in the same line have found that all of them are making substantially the same lines of products and all are working at considerably below their full capacity. The remedy for such an economic waste lies in co-operation. The various companies are combining into an association, allocating the full production of one commodity to one factory, the full production of another to a second factory and so on, leaving a number of factories free to take on new products which are the creations of inventors.

"As one typical industry which could make use of suitable new products, take the foundry industry. Foundries generally have too much plant and too little new business. Here and there over the country are foundry companies which are 'licking' the situation. They are manufacturing products which require castings. For example, out in Chicago is the Chicago Hardware Foundry Company.



A GUN FACTORY IN PEACE TIME

They advertise a product called 'Sani-Dry' which, with a turn of a button, sprays warm air over your hands and dries them after washing, cutting out towel expense and otherwise recommending itself especially to factories, schools and other institutions.

"It is certainly a day when the inventor can come into his own. You know of course, that many of the great industrial organizations have scores of inventors on their staffs, researching—literally inventing to order. I know of a large company which had an oil-burning stove ready years and years before oil burners came into general use. The smaller companies can not do this and yet, if they are to survive, they must get new products and keep pace with other conditions of today's shifting market.

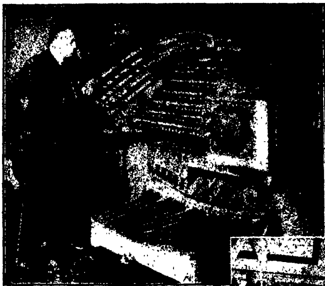
"At the same time that many inventors are letting their brains run wild, so to speak, many manufacturers are looking for some product along definite lines. Recently one of our company's clients had occasion to replace a patented container on which the patent had expired. This meant getting into touch with inventors and having them submit ideas and plans—literally inventing to order."

We asked Mr. Sherman what the inventor could get out of such an arrangement on the score of profit.

"THAT'S a question with a lot of dynamite in it," he said. "From what we see of inventors, it is safe to say that most of them have greatly exaggerated ideas as to the fortunes to be made overnight—striking it rich through another Ford car! It's surprising how many things are put up to you as being the 'Ford in its field.' In the foregoing instance, the inventor will not get rich from one invention—the new container. Why should he? The manufacturer makes the market before the invention is invented. The inventor will be well rewarded for his effort just as an advertising man or anyone else who sells the products of his brain to industry. This is true of many new products. Whereas the inventor is supplying something, the manufacturer also takes great risks. It is true enough that injustices have been done to inventors. On the other hand, think of the millions that have been sunk in inventions that never got across!"

We interposed at this point. "How are manufacturers to know of new products which formerly have not been in their line but which they can produce?"

"Through a thorough analysis of their own equipment and methods, coupled with a wide knowledge of the methods of manufacture of a wide range of other products," he answered. "As for the inventors, they must bring their work to the attention of such manufacturers. After all, the big problem is not how to invent, but how to find the manufacturer who needs the invention. There are many such manufacturers but to seek them out requires at least as much hard work as it takes to create the invention."

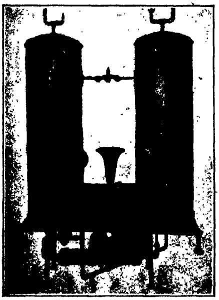


ORGAN CONSOLE

S. L. Rothafel is here shown standing beside one of the huge organ consoles of the Roxy theater, New York City. From this and other consoles, skilled organists control the flow of air through the organ pipes located in another part of the theater. Notice the complexity of the various organ controls

THE HOSPITAL

The really modern theater provides for every possible emergency. Here is part of the completely equipped hospital in the Roxy theater, where even a major operation can be performed if necessary. In addition, all of the ushers carry small first-aid kits for the treatment of fainting and the like



▲ **PIT ELEVATOR**

The entire orchestra pit, with all of the musicians, can be raised or lowered at will

◀ **NOISE MAKERS**

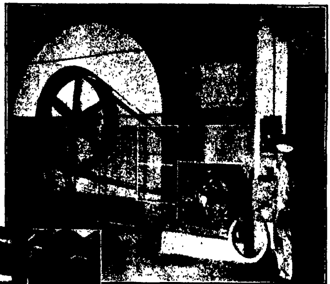
Various sounds for accompanying the pictures are produced with these instruments

PROJECTION BOOTH ▶

Standard projectors and those for "talking movies" are part of the regular equipment

The "Movie" Theater Up-To-Date

NOT so many years ago, the average motion picture theater contained only a series of seats, a screen, (more or less smooth), and a projection booth. The manager gave little thought to the comfort of the patrons—in the summer they might swelter, and in the winter be subjected to the vagaries of an inefficient heating plant. They came to see the "movies" regardless, because they were new. Patrons were not discriminating, and furthermore there was not much keen competition. But as the art of motion-picture production grew by leaps and bounds, and the pictures to be presented became more pretentious, the number of exhibition houses increased. Then, the effects of competition came to be noticeable, and the managers cast about for methods of attracting patronage to their particular houses. First, only special attractions were advertised as "drawing cards," but that was not always enough. Then managers began to improve their theaters and patrons became attracted to the various personal comforts that were offered. The old style of uncomfortable hard seats were replaced with other more spacious and upholstered chairs that made sitting through a long program a pleasure rather than a veritable torture. Soon the sign "20 degrees cooler than the street" became a common-place method of attracting the summer patron to the cool, comfortable, darkened depths of the theater. But the end was not yet. The theaters became more and more ornate, and still further attractions were added. It might be said that the ultimate in theatrical design for the presentation of motion pictures has now been reached. In New York City there are several large houses dedicated to the presentation of motion pictures that are, in every sense of the word, palaces. The Roxy theater, the result of years of planning on the part of S. L. Rothafel, well known radio entertainer, is an excellent example of these. We reproduce on these pages several photographs, specially posed for the SCIENTIFIC AMERICAN, of the more striking features of this well-designed theater. It seems that nothing has been slighted



WATER COOLER

The water that is piped to the various drinking fountains located in various parts of the theater is first cooled to the correct temperature by means of the complete refrigerating plant illustrated above. This is a great improvement over individual drinking-water fountains cooled by ice

VENTILATION

In order that the patrons may be in absolute comfort at all times, it is essential to have complete ventilation. In the Roxy, huge fans of the type illustrated above take care of this, effecting a complete change of air in the theater at predetermined intervals, thus completely getting rid of the stale, impure air

▲ AIR COOLER

In summer, the air in the theater is cooled by this large efficient refrigerating plant

◄ SWITCHBOARD

A section of the very complicated lighting switchboard is shown directly at the left

SEAT INDICATOR ►

In the balcony, this board of indicating lights shows exactly which seats are vacant

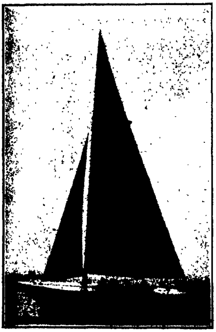
Many Modern Comforts Provided

and that every comfort of the patron has been thought of. No longer is the theater a mere place in which to view a motion picture. Instead it is more of a place of entertainment and a club combined. There are rest rooms, furnished in the best of taste and equipped with every comfort that patrons could possibly wish for. The lobbies are spacious and are so furnished and decorated that persons visiting the theater for the first time are entranced as they enter, and often spend some time in viewing them. Within the theater itself, the ushers conduct one to his seat with the utmost courtesy, and upon being seated, one finds that he is as comfortable as he would be in his own home. In the hot days of summer, there is always coolness to be found in the modern theater. This is provided by means of up-to-date refrigerating plants and ventilating systems. At convenient places there are inviting drinking fountains where water of just the right temperature may be obtained. Here again, refrigerating plants are employed and the cooled water is circulated to the various outlets. Should it so happen that a person be taken sick while in the Roxy theater, an attendant is always at hand to render first aid, and if necessary, rush the ailing one to the completely equipped hospital that is an integral part of the equipment of the theater. In the projection apparatus, many changes over older types of projection machines are noticeable. The booth is cool and well ventilated, and the machines are of the latest types. Most prominent among them are those which are arranged for the projection of the newest "talking movies." Complete installations for the presentation of two different types of the latter are available. Both of these systems have been described in this magazine. One is the Movietone, in which the sound record is made directly on the motion-picture film, in a narrow space at the side of the pictures. This was described in detail in the September, 1927, issue. The other method, described in the June, 1927, issue, is the Vitaphone, using a disk record for sound recording.

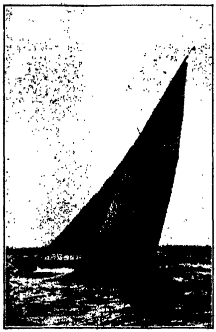
Scandinavian Six-meter Yachts Win

Photographs by Morris Rosenfeld

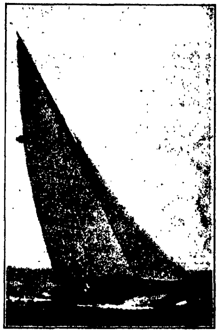
START OF THE THIRD GOLD CUP RACE, SAILED IN A FRESH BREEZE AND ROUGH



NOREG, WINNER OF SEAWANHAKA CUP



CLYTIE, DEFENDER OF SEAWANHAKA CUP

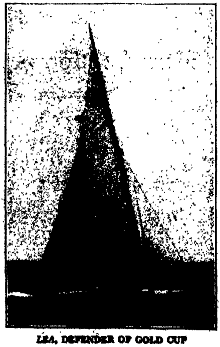


MAY-BE, WINNER OF GOLD CUP

THE Scandinavians have sailed back to Europe taking with them two international yachting challenge cups, Norway having captured the Seawanhaka cup, and Sweden, the Scandinavian gold cup.

The races, nine in all, were sailed on Long Island Sound and in winds which varied from very light airs to fresh breezes of 20 knots or more. It was a case of fair winds and no favor, and it is frankly admitted that the clean sweep made by the Norwegians, under a wide variety of weather conditions, proves that the foreign designers and yacht builders, at least in the design and construction of the smaller racing craft, have taken a very decided lead over this country. They seem to have achieved in the smaller classes the same supremacy which we have shown so long in the larger yachts built for competition in the famous "America's" cup contests.

The Seawanhaka cup, put up some 30 years or more ago for international contests, was carried overseas long ago and, after traveling to and fro as it was captured by various foreign clubs, was brought back to this country two years ago by the American six-meter yacht *Lanai*. In this year's racing, the Norwegian *Noreg*, owned by Crown Prince Olaf and associated yachtsmen, lifted the Seawanhaka cup by winning two out of three races.



LEA, DEFENDER OF GOLD CUP

The Scandinavian gold cup put up by the yachtsmen of northern Europe for international competition, and won recently by America, was challenged for by seven nations: Norway, Sweden, Finland, Denmark, Holland, Italy and England, each of which sent its best boat to Long Island Sound. The Scandinavians eliminated all competitors, and before the last race each of them had won two races, the Swedish boat *May-Be* winning the third race and the cup.

The races were won, not mainly by seamanship, as many suggested, but because the form of the boats and the cut of their sails were superior. This was proved when, in a race for all nine boats, in which the craft changed skippers, our Sherman Hoyt brought the Scandinavian yacht, *May-Be*, home again an easy winner.

THE CORE MAKERS' TABLES

carry the cores to the baking ovens

HERE THE FLASKS ARE PREPARED FOR POURING

molds as they move, preparatory to the pouring operation which is illustrated below

CHARGING A CUPOLA ▲

Continuous charging of each of the six cupolas is carried on entirely by machinery in the new Buick foundry as shown above. The materials are weighed and placed in the big bucket, which is hauled up through a hatchway cut in the floor, then pushed inside the cupola. At this point in its journey, it is tipped over, dumping its contents into the seething mass in the cauldron below

▲ POURING AND COOLING

(Above) Overhead trucks coming from the cupolas tilt the molten iron into hand ladles, also hanging from monorails. The workmen stand on a moving platform which keeps pace with the moving flasks. (Left) From the shake-out grates, after removal from the molds, the castings travel on overhead conveyors for an hour and a half to cool them sufficiently for further foundry handling

The New Modern Foundry Arrives

HAVE you ever stood in the gloom of a foundry? Remember the brawny, panting, sweating gnomes, bare from the waists up, dodging about the floor with ladles of liquid flame? Have you heard the scream of pain as molten iron spilled upon a workman's hand? Have you seen a man drop senseless from the heat and the poison-laden gasses? That picture is fading and in its place is dawning the foundry light and airy as a well-planned machine shop, ventilated by forced draught which keeps the air circulation constant, with ingenious machinery replacing the slaving humans for all of the heavier chores. The new day in foundry practice is opened with the swinging into production of the largest and most modern grey-iron foundry in the world by the Buick Motor Company at Flint, Michigan. Core making, assembly and baking, charging and discharging six 96-inch cupolas, pouring the molten metal, cooling, cleaning and finishing the castings—all rely upon machinery to an extent which makes the old-time foundryman rub his eyes with incredulity. The foundry building proper is 675 feet long and 123 feet wide, with cupolas, core room, pouring room and part of the cooling equipment, together with an elaborate conveyor system. The cleaning plant, 680 feet long and 240 feet wide, contains sand blasts, tumbling mills and other equipment to prepare the castings for the machining which puts on the final finish.

The Month In Medical Science

A Review and Commentary on Progress in the Medical and Surgical Field

Safety Pins in the Stomach

CASES are reported again and again of people who swallow all sorts of metallic objects without any reason, except perhaps a disordered mentality. A physician in Newark, New Jersey, recently operated on a Polish woman, aged 35, who came to the hospital because of some difficulty in the lower part of her intestines.

When the physicians made an X-ray examination they discovered a large mass of material in the stomach and the operation included the removal of this mass. It consisted of an interlocking bunch of safety pins, the total weighing 295 grams or ten ounces. The patient told the physician that she had first swallowed the pins 13 years previously because she was hungry, that she kept up the practice for four or five months, and that she had given birth to four children in the meantime without any special symptoms related to the safety pins.

RESULTS OF METAL DIET

A Polish woman swallowed a quantity of safety pins because, she said, she was hungry. X-ray photograph shows how they lodged in stomach from which position they were removed

IN the International Conference of Cancer Control held at Lake Mohonk, Dr. I. L. Dublin considered the chance of death from cancer for persons living today. His investigations were based on the records of the Metropolitan Life Insurance Company and showed that cancer as a cause of disability and death is increasing. Of course much of this increase is due to the fact that people nowadays are living longer than they used to, and they die from the diseases of advanced years rather than from the infectious diseases which formerly carried them off at an early age. In 1924 the probability at the age of ten of dying ultimately from cancer was exceeded only by the probability from three other causes: hemorrhage into the brain, chronic inflammation of the kidneys, and heart disease. Among women, cancer was third in the list, being exceeded only by heart disease and brain hemorrhage.

For each of the ages beyond 10 up to the age of 90, during the last 15 years, there has been an increase in the cancer hazard running approximately from 40 to 50 percent. The increase for women has been less than that for men, approximately 21 percent.

Dr. Dublin believes that the situation calls for intensive research of a type that is not yet being given to the investigation of cancer. Where we ought to be spending millions, we are spending thousands; where there are only hundreds of physicians especially trained to recognize and treat cancer early, thousands of physicians must be better informed on this subject.

The term cancer, as commonly used, is applied to all malignant tumors. Actually, malignant tumors are divided into at least two types. The first fact of importance about a tumor is its unlimited power of growth even at the expense of all the rest of the body. Frequently the tumor grows so rapidly that the blood vessels cannot keep up with it. Therefore, the cells distant from the blood do not receive sufficient nutrition to keep alive; they slough away and ulcers are formed in their place.

The cause of cancer is still unknown. Various theories have received special attention, particularly those having to do with the effects of chronic irritation. It seems to be well established that chronic irritation will not in itself produce cancer, but that it will cause changes in the tissues that favor the development of cancer. Cancer of the mouth and throat is far more common in people who smoke than in those who do not. The two lines of attack that yield the most satisfactory results are surgery, and the use of radiant energy in the form of either radium or the X ray.

Lead Poisoning

AN investigation of 35 industrial and commercial establishments in Nashville, Tennessee, made by Drs. W. S. Leathers and Hugh J. Morgan, revealed hazardous processes involving the use of dangerous substances in four of them. In one enameling plant, 39 people were examined for lead poisoning. Only 13 of the 39 men examined failed to show evidence of the disease. Workers in practically every branch of the plant were affected and a survey of working conditions indicated difficulties not only with the actual working conditions themselves, but also with the hygienic accommodations in general use. Rooms were improperly cleaned between working hours; the walls, ceiling and windows were covered with lead dust; men were careless in handling the enamel mixture; the washroom was small, dark, and poorly ventilated, and there were only two shower baths in which the men could wash off the traces of lead dust before leaving for home. Even the lighting was bad.

More than half of all the cases of metal poisoning found in industry are due to lead, and nine tenths of all lead poisoning can be prevented by keeping the dust and fumes from entering the mouths and noses of the workers. For more than a quarter of a century physicians and public health workers

have been agitating for hygienic conditions in this country. Nevertheless, the situation outlined in the plant in Nashville is not unusual, as similar plants are to be found in many communities.

The number of deaths from chronic lead poisoning has diminished about one half in ten years, but there are still thousands of cases of lead poisoning of varying degrees among workers which do not produce death promptly.

A survey of the enameling plant mentioned revealed not only lead poisoning, but also general defects in the workers which should have been corrected. Every one of the workers had some defect, so that none of them could be given an absolutely clean bill of health.

A survey of industries recently made by Dr. J. P. Leake of the United States Public Health Service revealed the fact that lead is not infrequent in the dust in the air of all sorts of industries. The signs of lead poisoning are available early in the blood of the person affected. Serious symptoms particularly relating to the stomach and intestines occur, as well as the later effects in the form of paralysis.

The Tallest American Boys

DR. HORACE GRAY of the Illinois Institute for Juvenile Research, and Dr. S. T. Nicholson of the Hill School in Pottstown, Pennsylvania, have recently concluded a study to determine what type of American boy is the tallest. The investigation included examination of boys in private schools and in public schools, and also a study made in California of especially gifted children. Boys in eastern boarding schools were found to be as tall or taller than gifted boys of all ages in California. Boys from eastern boarding schools also were found to be taller in general by from 2.1 to 6 percent than public-school boys at varying ages. Private-school boys are in general taller than those in country day schools.

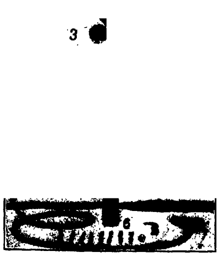
The ancestry of these boys is pretty generally American-British. Attempts are now being made in various schools in the United States to determine the relationship of height and weight to ancestry and to environment.

Rheumatism Cures

THE *Journal of the American Medical Association* has recently called attention again to a rheumatism cure exploited from Boston, and consisting mostly of aspirin and salicylic acid mixed with a little laxative and some vegetable matter. It is safe to say that 90 percent of patent medicines claimed to cure rheumatism are mixtures, with aspirin or similar drugs as their potent ingredient. Therefore, the patient purchases at a high price a commonly used drug and expects, largely because of the advertising associated with his purchase, to secure remarkable effects.

A New Pneumatic Hammer

DR. HORACE C. PITKIN of Boston has recently described a new pneumatic hammer for use in surgery of the bones. One of these has been installed in the orthopedic operating room of the Massachusetts General Hospital. The hammer is operated by compressed air. Its speed is controlled by a throttle situated on



PNEUMATIC HAMMER

Top: Hammer in use. Note convenience of throttle to thumb. Below: Operating-room assembly; 1—delivery hose; 2—reducing valve; 3—pressure gage; 4—air cleaner; 5—sterilizable tubing; 6—osteotomes; 7—the pneumatic hammer itself.

the pistol-grip handle and it may deliver 3800 blows per minute. Not any of the moving parts are exposed and yet it is possible to sterilze the hammer completely by boiling it without taking it apart.

Gasoline and Oil Poisoning

THE increasing use of gasoline and coal oil is bringing to light numerous cases of poisoning from these substances, particularly in children who drink almost anything that may be standing about in open vessels. The inhalation of the vapor of gasoline will cause headache, dizziness, shortness of breath, and if persisted in, unconsciousness and death. Drowsiness is an early symptom. In case of swallowing as much as an ounce of gasoline or benzene, unconsciousness comes on in from 10 to 15 minutes and death may follow shortly after. Most of the fatal cases occur in children. A woman aged 20 years died after drinking one ounce of gasoline, but another woman recovered after drinking a pint.

When coal oil is swallowed the effects are like those of alcohol, but much more poisonous, particularly in children. There is a burning pain in the throat and stomach, vomiting, a good deal of thirst, drowsiness, shortness of breath and perhaps unconsciousness.

When a child drinks either of these dangerous substances, vomiting should be induced as soon as possible. This may be brought about by inserting a finger into the throat or by causing the child to drink large quantities of hot salt water. The symptoms particularly of sickness and shock are best treated by a physician, who will provide medicinal stimulation when

Ultra-violet Rays in the City

AN investigation conducted jointly in the Department of Health of the City of Chicago and the Department of Physics of the University of Chicago by Drs. Herman N. Bundesen, commissioner of health, Harvey B. Lemon, I. S. Falk and Mr. E. N. Coade, reveals the fact that not enough ultra-violet light comes through from the sun in Chicago during the winter months to be of any significance. Under the supervision of Prof. Henry G. Gale of the University and Prof. A. J. Dempster, records of Chicago's sunlight were made daily from November, 1926, to May, 1927. Every day a photograph of the sun's spectrum was taken on a portrait film. The value of the sunlight as recorded in Angstrom units measured from 2900 to 3200. Investigations made by Dr. Alfred Hess in New York City show that light of this potency has little effect in preventing rickets. In March, when Chicago's atmosphere is heavily laden with smoke, the amount of ultra-violet rays coming through is not sufficient to have potency. The actual fact of the matter is that the ordinary incandescent bulb has about as much power as the sunlight of Chicago in winter.

In addition to studying the effects of sunlight, the investigators studied the power of special forms of window glass to transmit ultra-violet rays. Their reports agree with those of the Council on Physical Theray of the American Medical Association to the effect that the special glasses manufactured for this purpose will transmit such ultra-violet rays as come to them from the sun.

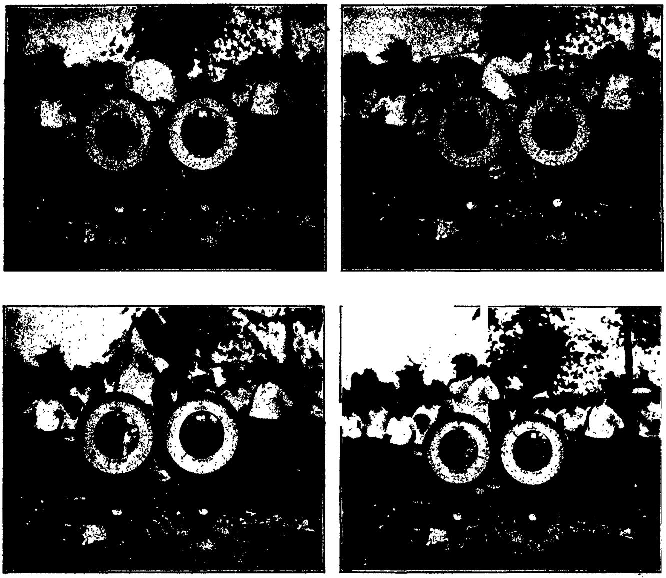


FIGURE 4

Which Foot Supports a Golfer's Weight?

By C. BOND LLOYD

GOLF writers, players and instructors have argued and theorized for years as to how the weight is shifted and distributed during the golf swing. There has been much controversy, particularly as to how the weight was distributed at the top of the swing.

Harry Pressler, one of California's leading teachers, says in part: "As the club goes back, the weight shifts to the right until at the top of the swing, 80 percent is on the right foot. The left heel is off the ground and the left shoulder is around until it is almost on a line with the ball. As the club comes down the weight shifts to the right, 90 percent of the weight being on the right at the finish of the swing." I have no idea as to where Harry gets his information about the weight shift. The photograph, Figure 8, of Mr. Richard T. Jones, Jr., of New York, a very fine player, shows that, at the finish, his weight is practically evenly distributed, there being only five pounds difference in favor of the right.

Johnny Farrell, well-known eastern professional, says: "As the club goes back, the left leg has continued its inward movement and the right leg stiffens, giving the appearance of bearing most of the weight. This, however, is an illusion. At the top of the swing the weight is evenly distributed and the body still maintains its balance without sway." Pressler and Farrell express widely different opinions as to the weight distribution. Harry Vardon is emphatic in saying, "At the top of the swing the weight is on the right foot." J. H. Taylor further emphasizes this when he says, "As the club swings back, the weight should be shifted by degrees until, at the top of swing, the whole weight is supported by the right leg."

P. A. Vaile, who has written many books on tennis and golf, says, "Let us consider the distribution of weight in the drive, which is of fundamental importance. Where is the main portion of the weight at top of swing? The winners of 16 British Championships say that the weight is mainly on the right foot. They are absolutely wrong. The weight is mainly on the left foot and never by any possibility on the right."

During a national amateur tournament, held at Minikahda, I had an opportunity to place two gravity scales for test purposes. A series of fast graflex pictures and also motion pictures showed that the weight shift varied, depending on who played the shot. Mr. Harold Weber, a very sound golfer, showed at top of swing 81 pounds on the left and 68 on the right. Ellsworth Augustus, who is a very long driver, showed 68 on the left and 122 on the right.

Still more interesting were the tests

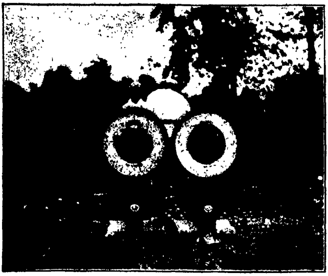


FIGURE 5

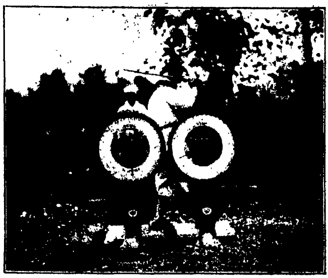


FIGURE 6

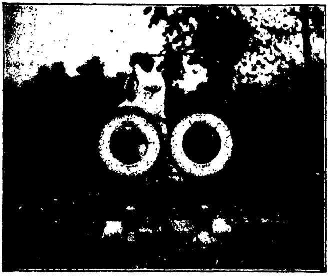


FIGURE 7

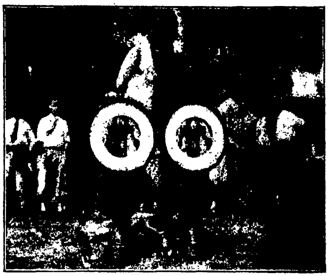


FIGURE 8

made during the swing of Jimmy Kenny, well-known professional at the Sylvania Golf Club.

Figures 1 to 4 show Jimmy driving. He hit what is known as a "screamer" during this shot. It was necessary to use four cameras during the swing. Figure 1 shows the stance with weight distributed as follows, 83 on the left and 81 on the right. Figure 2, at top of swing shows 84 on the left and 80 on the right. Figures 3 and 4 show the shift from right to left, not left to right, while at the complete finish, the weight is mostly on the left.

In Figures 5, 6 and 7, Kenny is seen making a shot with a midiron. Note that slightly more weight is on the left foot than when using the driver. At top of swing he shows 102 on the left and 62 on the right foot. At the finish, all but 14 pounds is on the left foot.

Either the British "experts" are wrong or Kenny will have to start changing his swing. When Jimmy was interviewed with reference to weight shift he said, "Why shift the weight during the swing? If it is transferred to the right, it will cause the player to sway, which means that the head of the club in the down swing does not hit the ball squarely and has a tendency to hit behind the ball or else catches it on the up swing. If I wanted to get 80 percent of my weight on the right foot at the top of swing, I would have to sway at least five inches. If this is sound golf, I will have to revise my method of teaching."

After some 20 years of taking motion pictures of expert players as well as of novices, I have noted that the "dubs," as they are inelegantly called, have one very pronounced fault. This is body sway. Falling back after hitting is another very common fault. In talking to one of the poorer players recently, after I had shown his motion picture, he remarked, "How can I get my weight on the right foot at top of swing as the experts tell me without swaying?" My only answer to this was that I was convinced that the "experts" really did not know what the weight shift was. Alexia Sterling Fraser well says, "Keep the weight well on the left foot. It will steady the body and prevent swaying."

Who Is Right?

IT is no exaggeration to say that—at least according to the best versed statisticians in that field—there are not less than two millio[illegible] United States today. Evidencing this fact is the keen interest which many of our readers have shown in the articles which we have from time to time published, discussing different phases of the famous Scottish pastime.

The accompanying article by C. Bond Lloyd will doubtless cause considerable discussion. In fact, it has already, in manuscript form, created the expression of diverse opinions on the part of many golfers of experience. We shall publish in a forthcoming number an article by one of the most prominent of our professional players, giving his views on the subject, and discussing his premises fully from the standpoint both of the prominent player and teacher.

The Editor.

Learning Language By Its Feel

The "Teletactor" Enables the Deaf to Hear Through Their Finger Tips

By ROBERT H. GAULT, Ph.D.
Northwestern University

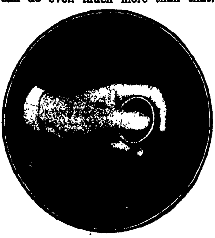
HOW far can one sense organ go in substituting for another that is out of commission? The blind man learns casually and by training, too, that touch can carry him a long way. What can this sense do for the deaf man? Can he by any sort of instrumental aid become aware of speech, and learn its meaning by the way it feels upon his skin? Can he obtain any help in this direction by way of the "feel" of speech? Can the same feel be of any service to the mute or the semi-mute in his effort to improve the quality of his spoken language? Recall that the mute is in his speechless state because he cannot hear his own voice, to say nothing of the voices of his neighbors. He lacks the guide that hearing affords.

THE above questions are aimed at the possibility of substituting organs of touch for ears. Theoretically that does not sound so bad because if we go back far enough toward the beginning of animal history we find a point at which a sensitive skin did serve as ears. Primitive forms of animal life *feel* their environment through the sense of touch or of vibration.

This alone suggests the possibility of developing a method whereby speech may be received through the sense of touch exclusively.

And it raises the query—how sensitive is the skin? How nicely can it discriminate amongst all those signs that, to the ear, compose meaningful language?

To begin with, the sense of touch in the skin is able to detect vibrations of a suitable intensity in a solid object when they occur even as frequently as 2600 to 8000 times a second, and it is extremely probable that it can do even much more than that.



SINGLE UNIT TELETACTOR

The single unit first used was closely similar to a radio head set

Until very recently the highest figure known in this connection was 1600. I have been able to determine the higher figure by means of a five-unit "teletactor."

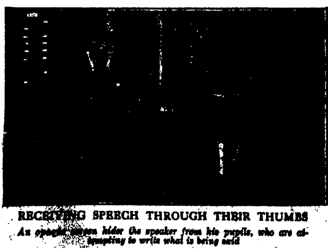
This "teletactor" was designed and built for me through the courtesy of the Bell Telephone Laboratories, and embodies their expert knowledge of electrical systems for communication. Telephone currents from a high-quality transmitter pass through a vacuum-tube amplifier and into an electrical filter where the frequencies of the complex speech-current are separated into five groups by the special filter. Each group of frequencies then goes to a separate receiver unit so that each unit is actuated by only a definite range of speech sounds. The five receiver units have a common mounting so that the "teletactile listener" may hold it in his hand with his thumb or a finger resting on each of the five receivers. The receiver unit for the thumb responds to speech vibrations less than 250 per second; for the little finger to those of more than 2000 per second; the other fingers are affected by vibrations in the ranges of 250-500, 500-1000, and 1000-2000 respectively.

Now, to discover whether a finger can detect vibrations that are occurring 2000 or more times a second, disconnect the filter from all units excepting the one in contact with the little finger. (See the diagram on the opposite page.)

THEN let some one pronounce several vowel qualities into the microphone or employ an oscillator by which one can produce vibrations of a known frequency. Does anything happen against the little finger? Persons with a moderate degree of tactual training will answer in the affirmative. They can feel vibrations that are occurring at the rate of 2600 (and more) times a second. This is a very important finding. All the energy of speech is carried by frequencies of vibration far below 2000 a second.

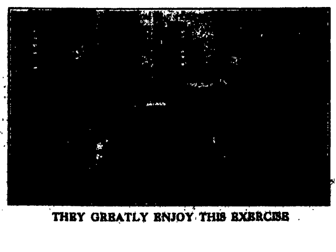
The skin equals the ear in detecting differences in intensity of vibration (differences in *loudness*, as a hearing person would say).

Fingers are by no means as expert as ears at distinguishing between frequencies—distinguishing *pitches*, as the ear says it. But fingers have many more resources than I have indicated so far. After suitable practice



RECEIVING SPEECH THROUGH THEIR THUMBS

An opaque screen hides the speaker from his pupils, who are attempting to write what is being said



THEY GREATLY ENJOY THIS EXERCISE

they can identify vowel and diphthongal qualities and some consonantal qualities combined with vowels. They can pick up words. They can feel accent, emphasis, rhythm and tempo in speech. They can catch the smaller and greater pauses that occur in connected speech as it comes through the teletactor system. In other words, they can lay hold upon the pattern of sentences and of continued discourse. This is an indispensable tool that all hearing people put to great use. We hear fewer words as words than we imagine. We go a long way toward understanding our neighbor's conversation by the *swing* of his speech.

During more than four years the writer has been making experiments looking toward a wide application of the tactual sense to develop the use of language amongst young deaf folk. During the last three years the enterprise has been under the auspices of the National Research Council, now under the Carnegie Institution of Washington. In May, 1926, two young deaf people managed to pick up a story of about 250 words—a story they had never known before.

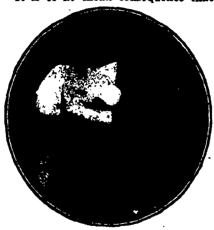
IT was composed for the occasion. They "heard" it through the thumb of the left hand and wrote it down with the other hand. These two in two years had had an aggregate of 280 and 290 hours of laboratory practice on a great variety of exercises.

But suppose the "teletactile listener" can at the same time see a speaker's face and feel his words. Then, assuming about 60 hours of tactual training, the "listener" can interpret speech anywhere from 30 percent to more than 100 percent more accurately than he can do without the aid of touch but by seeing the speaker's face, and by that means alone. Much of speech that can be felt cannot be seen. This opens up a way whereby the training and education of the deaf in their schools can be greatly speeded up. The prospect is all the more bright because a group of persons can simultaneously feel a given speaker's voice, assuming that several receivers are connected in series with the microphone. Accent, emphasis, rhythm, tempo—the pattern of sentences can be felt through the teletactor, and by these characters alone one can go a long way toward understanding speech. In fact, when we hearing people listen to conversation we do not begin to single out all the words that are uttered. We catch large patterns and jump at their meanings.

PRACTICE

A pair of subjects receiving the speech of the author in their thumbs and simultaneously reading his lips [illegible] while they attempt [illegible] write—a method that greatly facilitates the development of a language sense and improves lip-reading. The 300 hours of drill required to enable one [illegible] us of

It is of no mean consequence that deaf subjects enjoy the feel of speech. They get a thrill from the swing of it. But it is not alone from the "swing." They like the feel of some vowel and diphthongal qualities more than others. This raises the question whether one can learn to enjoy music from feeling it. Preliminary experiments in this direction have brought very encouraging results.



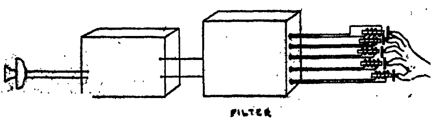
FIVE ELEMENT TELETACTOR

Each finger and the thumb receives its assigned range of pitch frequency

Can the method afford an independent means of understanding speech? The only way to answer satisfactorily the question is to equip a group of deaf youngsters with teletactors at the very moment of their first entering school and to keep them in touch with this equipment throughout the school day and successive school terms. If they can live with tactual signs of meanings, as the rest of us have lived with auditory signs, I am convinced they can learn to understand speech by its feel.

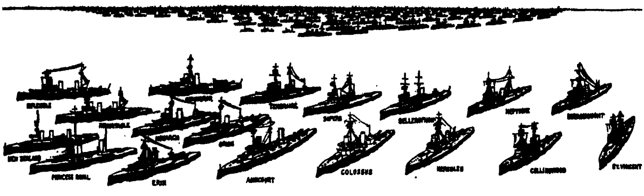
The sense of touch opens a gate to the improvement of speech. Here is a superior method for making the mute acquainted with syllabication, accent, emphasis, rhythm, and the tempo of speech, in short, with the pattern of language as the experimenter speaks it. Once the feel of all these characters of speech gets "into the bones" it bears good fruit in the manipulation of one's own speech—even in pronunciation of isolated words. Furthermore, when the semimute feels his own voice in the receiver upon his own fingers he makes a very interesting discovery: that he can do with his vocal apparatus more than he ever could before. Here is a motive that encourages him to play with his own voice. Put a group of semi-mutes simultaneously into connection with the teletactor system, let each of them in turn use his voice at the transmitter; there is a profitable game of exploration and discovery that they will play at indefinitely.

WHAT is the future of this work? Schools for the deaf will, I think, undoubtedly some day be equipped for making full use of the sense of touch as a medium through which to teach language, and in all school exercises in which language is a tool; the teaching of geography, for example. This means that they will have a microphone at the teacher's desk or suspended from her neck. Beneath the desk will be the necessary batteries and amplifier. At every desk occupied by a deaf pupil will be a receiver which the pupil may hold in his hand to feel the teacher's words, while at the same time, if necessary, he observes her face. Some day there may be a portable "teletactor" for out-of-school use.



SCHEMATIC DIAGRAM OF THE TELETACTOR SYSTEM

At left is the transmitter. Wires connect it with the receiving unit whose filter sends to each finger its assigned frequency range. The finger impressions are combined in the brain



HOW GREAT BRITAIN FULFILLED THE WASHINGTON TREATY

The 18 British dreadnoughts in the foreground were scrapped within one year of the Washington Treaty. The fleet on the horizon includes 639 ships, most of which had been destroyed, voluntarily, before the Treaty. In that fleet are 24 battleships, 83 armored and unarmored cruisers, 55 high-speed scout cruisers, 10 flotilla leaders, 277 destroyers, 116 submarines, 95 torpedo boats, et cetera

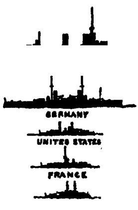
The Post-War Navies

How the Overgrown War Fleets of the United States and Great Britain Were Brought Down to a Peacetime Basis

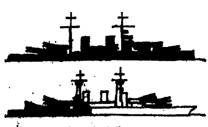
By J. BERNARD WALKER

SINCE the close of the World War, and particularly following the Washington Treaty, so much insidious and disturbing naval propaganda has been spread abroad, that there is a crying need for a plain statement of the facts regarding the naval situation, covering the period from the Armistice and the Treaty up to the present day.

At the outbreak of the war it was realized that the keystone of the whole system of allied attack and defense, present and prospective, was the British navy. If the British Empire, widely scattered, was to develop its full strength on the Continental battlefields, if America was ever to land its armies in France, the powerful German fleet must be shut up within its home waters, and the high seas must be swept clear of enemy raiding forces. This was a gigantic task, and it was accomplished only by building up the already powerful British fleet until its preponderance of strength was overwhelming. Every shipyard, public and private, was working at full pressure during the four and one-half years of the war.



FLEET STRENGTH IN 1914

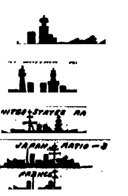


DREADNOUGHTS DESTROYED

Completed tonnage destroyed by United States, 195,448 tons; by Great Britain, 473,570 tons

It is not generally known that from 1914 to the Armistice, a mighty fleet of new fighting ships was added to the British Navy. In his notable work, "Navies and Nations," just out, Bywater writes: "At the date of the Armistice the white ensign was flown by 1354 combatant vessels, with an aggregate of 3,250,000 tons, forty-two of these being capital ships of the dreadnought type." Also there were 24 pre-dreadnoughts, 109 cruisers, 13 aircraft carriers, 527 destroyers and torpedo boats, and 137 submarines. This gigantic force completely overshadowed the combined fleets of the United States, France, Italy and Japan.

When the surrendered German fleet committed *hari kari* at Scapa Flow, the last vestige of a potential enemy disappeared, and Great Britain vol-



STRENGTH SET BY TREATY

The Treaty moved the United States fleet from a poor third to front rank

untarily set about the work of reducing her fleet to a peacetime basis. The work of demolition went forward so rapidly that early in 1923, before the French had signed the Washington Treaty, she had struck off her navy lists, and scrapped, dismantled or sold for scrapping, the huge fleet shown in the leading illustration of this article. This included a total of 657 ships of a total displacement of over 1,500,000 tons. Into this enormous scrap heap went the 18 modern, war-tested dreadnoughts, destroyed in accordance with the Washington Treaty of 1922. All this was done before we had scrapped a single ship, the United States and Japan awaiting the signature of the French

U. S. Dreadnoughts Destroyed

	Tons Displ'c't	Percent C'mpl'd	Tons D'tr'd
South Dakota..	43,200	38.5	16,632
Indiana.......	43,200	34.7	14,991
Montana......	43,200	27.6	11,923
North Carolina.	43,200	36.7	15,855
Iowa..........	43,200	31.8	13,737
Massachusetts.	43,200	11.0	4,752
[illegible]	43,500	33.8	14,703
[illegible]	43,500	22.7	9,875
Saratoga*......	43,500	35.4	15,399
[illegible]......	43,500	4.0	1,740
[illegible]ation...	43,500	13.4	5,829
United States..	43,500	12.1	5,264
Delaware......	20,000	100	20,000
North Dakota..	20,000	100	20,000
Washington....	32,600	75.9	24,743
			[illegible]3

TABLE 1

nation, which they had a perfect right to do.

This fleet of 657 destroyed ships included 38 dreadnoughts and pre-dreadnoughts; four battle cruisers; 33 cruisers, armored and unarmored; 55 light, high-speed scout cruisers; 10 flotilla leaders of over 30 knots speed; 277 destroyers of 27 to 35 knots speed; 95 torpedo boats; 20 monitors built during the war; 116 submarines and four extemporized aircraft carriers.

This wholesale voluntary scrapping of all her pre-dreadnoughts, and 18 of the dreadnoughts that fought in the first line at Jutland, was done in advance of the required date, as a member of the government said in Parliament at the time—"that this country should give a lead in good faith, and to show that it is our intention to carry out, in the spirit and in the letter, this great Treaty for the limitation of armaments."

The famous Washington Treaty of 1922 aimed at the reduction of

Tons Destroyed

	Dread-nought	Pre-Dread-nought
U. S.......	195,443	302,749
G. B.......	473,570	344,800

TABLE 2

the swollen wartime fleets to a peacetime basis. It was called by the United States Government, speaking through its President. This was done because we recognized that the enemy's ships had been sunk, and that the only remaining fleets were those of the nations that had been in active and close alliance during the late war. It is true there was an outbreak of the sporadic antagonism between the United States and Japan, which was preventing these countries from following the lead of Great Britain in stopping all big ship construction and reducing the size of their wartime navies. Both the United States and Japan were building capital ships at a rate which boded ill for the future, and the nervous tension was being strained to the breaking point by a widespread and very active propaganda that threatened to have disastrous results.

The Washington Conference was a brilliant success, at least so far as capital-ship strength was concerned. The five leading nations, United

British Dreadnoughts Destroyed

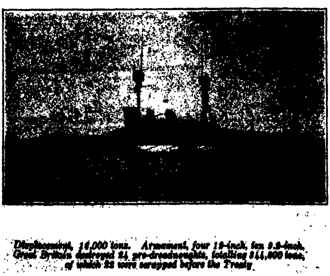
Dreadnought..	17,900
Bellerophon...	18,600
St. Vincent....	19,250
Inflexible	18,750
Superb.......	18,600
Neptune......	19,900
Hercules......	20,000
Indomitable...	18,750
Temeraire........	18,600
[illegible]w Zealand......	18,800
Lion...........	26,350
Princess Royal ..	26,350
Conqueror..............	22,500
Monarch..............	22,500
Orion..............	22,500
Australia..............	19,200
Agincourt..............	[illegible]
Erin..............	23,000
Thunderer..............	22,500
K. George V..............	23,000
Ajax..............	23,000
Centurion..............	23,000
*Hoods—Four............	5,520
	473,570

*Four super-Hoods begun

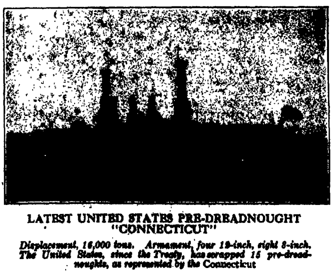
TABLE 3

States, Great Britain, Japan, France and Italy, agreed to reduce their capital-ship strength to a ratio of 5–5–3–1.8–1.8 respectively. Great Britain agreed to give up her traditional naval supremacy and accept parity with the United States, acting under the conviction that war between the two countries was unthinkable. She agreed to reduce her fleet still further by scrapping 22 capital ships that had fought at Jutland, and the two pre-dreadnoughts, *Commonwealth* and *Agamemnon*, which were all that remained of the pre-dreadnought fleet that she had already scrapped. Also she abandoned the construction of four super-Hoods of 48,500 tons upon which she had done a total of 5520 tons of construction.

THE United States agreed to break up the completed dreadnoughts *Delaware*, *North Dakota*, also *Washington*, the last named being 75.9 percent completed at the time. Also



Displacement, 16,000 tons. Armament, four 12-inch, ten 9.2-inch. Great Britain destroyed 24 pre-dreadnoughts, totalling 344,800 tons, of which 22 were scrapped before the Treaty



LATEST UNITED STATES PRE-DREADNOUGHT "CONNECTICUT"

Displacement, 16,000 tons. Armament, four 12-inch, eight 8-inch. The United States, since the Treaty, has scrapped 15 pre-dreadnoughts, as represented by the Connecticut

we agreed to break up 12 super-dreadnought battleships and battle cruisers of over 43,000 tons displacement, which were upon the building ways in various stages of construction, the most advanced being the *South Dakota*, 38.5 percent completed, the least advanced being the *Ranger*, upon which a total of 4 percent had been done. The Washington, 75.9 percent complete, was also destroyed.

LATEST BRITISH TREATY DREADNOUGHT "NELSON"

...aximum allowed by Treaty); armament nine 16-inch guns; twelve ...-do guns. Note that the 16-inch battery, in three-gun turrets, is grouped forward of a curious structure which carries bridges and fire controls

The total amount of constructed dreadnought tonnage thus destroyed by the United States covered 15 ships and totalled 195,443 tons, as shown in Table 1. With the exception of the four super-Hood ships, all of the 22 British dreadnoughts were completed ships that had fought in the war. The total additional amount she thus destroyed amounted to 478,570 tons, as shown in Tables 2 and 3.

The outbreak of the war found us in the third position in naval strength. At that time, the navy and its friends were urging that to the United States rightly belonged the position of second in strength. That was the mark set and accepted. As the result of the war and the treaty, we have moved up to the first position, ranking with Great Britain. This was accepted as a gratifying result by the American people, by the press of the country, and by the great majority of the personnel of the navy. We were raised from third to front rank.

UNFORTUNATELY there existed and we fear still exists, though in less degree, a small but vociferous section of the navy that is bitterly opposed to the Treaty. It includes a few of our older officers, mainly retired, who do not appear to realize that the war of the Revolution is over. To them must be added a few of the younger officers of strong racial and religious prejudices. These constitute a small but loudly vocal body of propagandists, who have bitterly assailed the treaty, claiming that our navy's interests were sacrificed to Great Britain, who "put one over on us," and contrived to prevent us from becoming the leading navy in the world.

How in the world a nation that sacrificed one and one-third million tons of fighting ships *voluntarily*, and then followed that up by destroying nearly 500,000 tons of completed dreadnoughts, can be accused of "putting one over" on a nation that has broken up only 498,192 tons of dreadnought and pre-dreadnought construction, is puzzling to the common-sense mind of the average layman.

LATEST UNITED STATES DREADNOUGHT "MARYLAND"

Displacement 32,600 tons; armament eight 16-inch guns; twelve five-inch anti-torpedo guns. The 16-inch battery carried in four two-gun turrets, mounted two forward and two aft, giving better all-around fire than the Nelson

This endeavor to persuade the good people of the United States that we were the only country that made any real sacrifice is so wide of the mark as to be positively funny. No less an authority than Secretary Wilbur of the navy has stated before the Senate Naval Committee that at the Washington Congress we gained everything that we wanted.

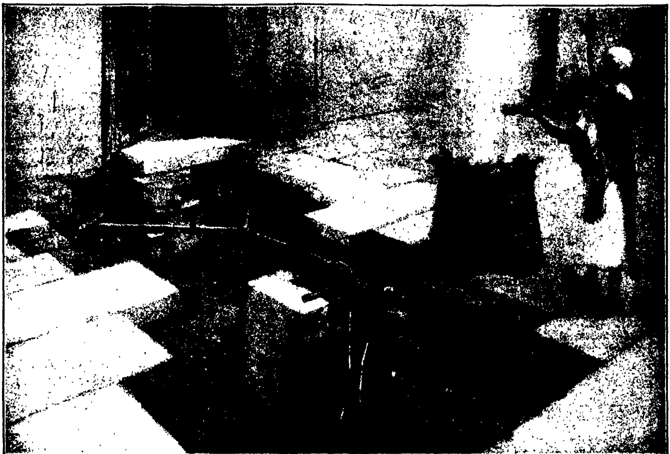
We hold no brief for the British or any other foreign navy, but we do hold a brief for incontrovertible truth, for fair play, and for good sportsmanship. This present article is written solely for the purpose of putting the exact facts of the naval situation, from the date of the Armistice down to the present hour, before the American people and their senators and congressmen. We feel assured that this presentation will prove to all fair-minded people (and that means the one hundred and ten million people of the United States) that the propaganda against other navies, and notably against Japan and Great Britain, has been utterly untruthful and tending most dangerously to break down the fine spirit of understanding and co-operation, which had grown up among these nations as the result of their combined operations during the supreme trial of the Great War.

THE facts brought out in this article may serve to account for the failure of the Geneva Conference. Its futile ending is to be explained in large measure by the fact that the anti-treaty propagandists commenced their malicious work some weeks before the Conference opened, and continued at Geneva to carry it on most vigorously during the actual sessions.

We know that this is the case, because, before the Conference opened, we received from Geneva several articles from one of the most active anti-treaty writers, the burden of which was that the United States navy was already below Treaty strength.

Happily, we have the assurance of our own and the British representatives at that Conference, that the discussions in the Conference itself were entirely friendly, and that the failures to agree contain no threat of disturbing competition.

Miracles Made To Order



Courtesy of The Illustrated London News

HOW ANCIENT EGYPTIAN PRIESTS IMPRESSED THE FAITHFUL

The temple doors open at the mere bidding of the priest! A miracle? To the gullible Egyptian of the period it must have seemed so. What, then, actually took place? The heat of the incense burning on the altar warmed the air contained in its base, thereby expanding it. This in turn depressed the level of the water in the communicating jug below, and pushed some of it out into the counterweight, opening the doors

MR. WILLIAM REAVELL, President of the Institution of Mechanical Engineers, Great Britain, in a recent address on air compression, explained the two ancient Egyptian "miracles" reproduced here from *The Illustrated London News:* The statue at the right, one of the famous colossi at Thebes, 1450 B. C., saluted the sun by whistling. The two cavities A and B were separated by partition C. Tube D passed through top of partition. Both sides were filled with water, up to E. Air in A, warmed by the rising sun, depressed the water level, forcing water through tube into B, whose volume of water was thus increased. This compressed the air in cavity B, driving it up tube F to hidden whistles. Since time immemorial the unintelligent have tended to appraise the worth of religions by the ability of the priesthood to perform miracles. Conversely the priests understood that it was necessary, in order to insure the adherence of the masses, to meet this demand. This tendency occasionally crops up today.

"Old Ironsides" in Dry Dock

Placing the Badly Decayed "Old Ironsides" in Dock for Reconstruction—a Delicate and Difficult Task

THE United States ship *Constitution*, familiarly known as *Old Ironsides*, is now in dry dock at Boston for her fourth reconstruction since she was launched at the same port in 1797. She is without question the most famous ship in the annals of the United States Navy. None has a more brilliant record, and none, surely, is so safely enshrined in the affections of the American people.

The *Constitution* saw service in the French War, helped to clear the West Indies and our coast of the French cruisers, and a few years later bombarded the Fort of Tripoli and subdued the Barbary Corsair States. In the War of 1812 she won a succession of victories over British cruisers, which so increased the prestige of the United States that secession was averted and the war was brought to a close.

The fact that *Old Ironsides* is undergoing her fourth reconstruction testifies to the abiding place which she holds in the love and admiration of the American people who are doing the work.

Her first reconstruction was done at Boston in 1833; the second took place in 1871 when she was rebuilt at the Philadelphia Navy Yard; the third, a partial reconstruction, took place at Boston in 1906. It was at this time that the good ship came very near passing out altogether, for the navy decided that since she was unsuited for any naval service, and was not worthy of repair, she should be used as a target and sunk by gunfire. This aroused such a storm of protest throughout the nation that Congress appropriated 100,000 dollars for her rebuilding. For this limited sum the *Constitution* was resparred and rerigged, and some emergency work done on her hull. In the intervening 21 years the timbers of the hull had been so eaten away with dry rot and other decay, that only complete rebuilding would have saved the ship from oblivion.

The cost of this work is estimated at about 650,000 dollars, and in order to stimulate interest in this richly historical ship, it was decided to make an appeal to the school children and young people of the country for voluntary contributions. Sufficient funds are now in hand to start the work, and recently the ship was placed in dry dock.

"OLD IRONSIDES" IN DRY DOCK

1. Hull heavily shored up to prevent distortion. 2. Afloat in dry dock. 3. Removing the heavy masts. 4. Two 24-pounders on starboard bow. At left, original anchor-stop

Now it will readily be understood that since very little work was done upon the hull in 1906, and over half a century has elapsed since the second reconstruction of the hull in 1871, the whole structure must necessarily be in very poor shape. Dry rot has done its work only too well. It is possible to tear some of the timbers apart by hand, for they consist merely of an outer shell, filled with the friable material left by dry rot.

To place a badly decayed ship of the size and weight of *Old Ironsides* in dry dock was a task which caused the naval authorities no little anxiety. So long as the ship was afloat, the water provided a support that was evenly distributed throughout the hull at any given level; but in dry dock the bulk of the weight would rest upon the keel and bilge blocks. It was realized that unless additional supports were provided, there would be danger of the hull settling so badly out of shape as to render reconstruction on the original lines of the ship a doubtful and extremely difficult problem.

Before the unwatering of the ship began, all movable weights were taken out of her. The heavy yards and masts were removed, as were also the heavy battery of some 50 guns, and other weights such as anchors, cables and gear. Then, as the water was drawn away, a veritable forest of shores was put in place, sufficient to prevent any distortion.

Do Insects Feel Pain?

Although Deprived of Parts of Their Bodies, Some Insects Seem to Feel No Discomfort

By HAROLD BASTIN

INSECTS are richly endowed with delicately adjusted sense-organs, some of which enable them to perceive phenomena that make no impression upon our own grosser nerve-endings. Ants, for example, can see the ultra-violet rays of the sunbeam to which we are blind. Again, the tactile sensibilities of many insects—especially sightless, cave-dwelling species—surpass our powers of comprehension. It has even been suggested that certain insects have a kind of touch language.

Yet all this notwithstanding, we are faced by the extraordinary fact—attested by many students of insect psychology—that insects do not feel pain. True, there is some evidence to support the view that they suffer varying degrees of discomfort, especially when their antennæ are

IS IT IN PAIN?

The wings and abdomen of this wasp have been removed, yet it feeds greedily on a drop of fruit syrup. The syrup may be seen issuing from the truncated part of the alimentary canal, behind the thorax

pinched, or when strong corrosive substances are applied to their nerve-endings. But to pain, as we understand the word, they appear to be total strangers.

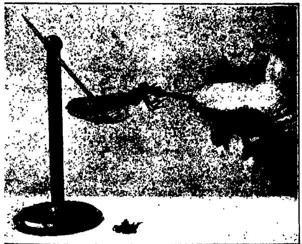
Should the reader be sceptical, the following instances will probably convince him. The late Auguste Forel, that painstaking investigator of insect sensitivity, desired to establish his belief that bees rely chiefly upon sight when they are searching for flowers. To this end he captured bumble-bees, and with scissors cut away all the front part of the head as far as the great compound eyes, including the antennæ and the mouth-parts, with their nerve-endings. When liberated, the mutilated insects immediately flew to flowers in the garden and tried repeatedly to feed—vainly, of course, since they had been deprived of their mouths. Many of us may deprecate experiments of this nature; but it is obvious that we cannot urge against them the arguments that are usually employed by the convinced anti-vivisectionist.

The painlessness of the dragon-fly can be demonstrated with equal certitude. If we amputate the whole of its abdomen, the creature not only continues to eat, but its appetite becomes literally insatiable because no limit is now imposed by its internal capacity. The food, comminuted by its jaws, simply passes through the thorax and drops out through the opening of the truncated alimentary canal. The Rev. Theodore Wood mentions that a dragon-fly which, by an accident, had lost its abdomen, devoured in quick succession and with perfect calmness and self-possession some thirty blue-bottle flies, and finally disposed in the same way of its own severed body!

In like manner ants and wasps, whose abdomens have been cut off, will gorge themselves with honey or fruit syrup with every appearance of enjoyment—the sweet substance forming a glistening globule behind the severed peduncle, or "waist," that is such a characteristic feature of these insects' structure.

That an insect will eat, apparently with relish, when it is in process of being devoured by a carnivorous species larger than itself, is a well established fact. Thus, a dragon-fly nymph when making a meal of some lesser aquatic larva, may fall a victim to a water beetle. The nymph does not, as one might suppose, straightway relinquish its prey, but continues calmly to feed, with the beetle gnawing at it.

Every field naturalist can cap such instances by others drawn from his own experience. The common garden spider (not, by the way, an insect in the strict sense of the word) will feed



EATING ITS OWN BODY

The entire abdomen of this dragon-fly has been cut off, and the still living insect is eagerly devouring it. The particles merely pass through what is left of the insect and fall from the thorax as shown

immediately upon its own leg should this chance to be broken. By the exercise of a little dexterity, a pin may be passed through the body of a sleeping moth without awakening it.

Enough has been said, however, to prove our original contention that insects seem to be entirely free from sensations of pain. Why this should be so remains a puzzle, alike from the standpoint of the physiologist and of the psychologist.

AND IT SLEEPS ON

Inventions New and Interesting

Novel Devices in Many Fields of Application Show the Wide-spread Interests of Inventors

CONDUCTED BY ALBERT A. HOPKINS

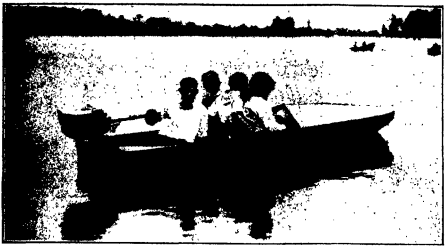
SECTIONAL GLOBE TEACHES GEOGRAPHY TO CHILDREN

One of the recent educational toys to appear on the market is illustrated directly above. It consists of a globe of the world, the various parts of which are separable. The continents are all made in sections so that they can be taken apart, and each country on each continent is also a separate block. When the parts are all assembled properly, a substantial globe results that can be used for reference, in just the same manner as any ordinary globe. In the right-hand illustration above is shown the factory in which these novel globes are made. Note forms used.

AIDS TO THE AMATEUR PHOTOGRAPHER

From Germany comes the pocket arc lamp for photographic use that is illustrated above. A small resistance screws in a lamp socket and governs the flow of current. The insert shows the details of the lamp and resistance.

Another portable arc lamp, made in this country, and resembling, when closed, a pocket camera, is shown in use and in detail above. It can be mounted on a small stand or held in the hand with perfect safety as is illustrated.

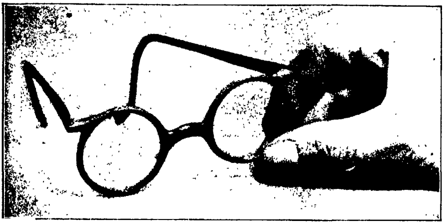


RUBBER BOAT CARRIES OUT-BOARD MOTOR

The rubber boat illustrated above consists of a thin yet strong rubber fabric which is cemented to the frame. The latter is made of a new rubber 'lumber."

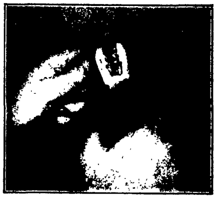
▲ WIRE STRIPPERS

The device for removing the insulation from wire, illustrated above, is automatic in its action. The first pressing of the handles cuts the insulation, and further movement strips the covering. The pliers shown below are adjustable so as to cut any thickness of insulation



FOR BETTER VISION TO RIGHT OR LEFT

By placing the bows higher up on the frame of the spectacles, one manufacturer claims that the wearer will experience greater ease when looking to the sides



EXERCISING MACHINE INVIGORATES THE BODY

It is said that 15 minutes exercise with the above illustrated machine is very beneficial. The rotating rollers are of soft molded rubber and are filled with air.

PUTTING IT AWAY

The exercising machine illustrated at the left can be stored in a closet as shown

Household Inventions

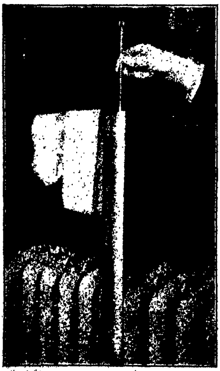
Interesting New Devices That Are Both Useful and Time Saving to the Modern Housewife

NEW REVERSIBLE ELECTRIC TOASTER

The toaster illustrated above shows a base carrying the heating element and supporting a reversible bread holder. After the bread is toasted on one side it can be turned over without the hands touching it or removing it from the grid. Directly under the heating element is a hinged tray which catches the crumbs

CLOTHES LINE HANGER

Does away with all knots and props. The line cannot slip, as the harder the pull, the tighter the clip holds. It is practical for both indoor and outdoor use



RADIATOR CLOTHES-HANGER

This rack will fit on any radiator, and can be used either in the home or office. The arms slide into the trough and the hanger can be placed in such a way that it becomes unobtrusive when not in use

A PENCIL AND TAPE-MEASURE

This combination tape-measure and pencil makes it unnecessary to carry around an extra rule. The tape-measure is on a reel in the top of the pencil. Pencil has a clip provided for conveniently carrying in the pocket, as shown in the above illustration.

FRUIT-JAR HOLDER

With this device it is not necessary to wait until the jars are cool enough to handle before sealing. With the jar-holder and lid-wrench one can either open or seal the jar while still hot, at the same time protecting the hands from injury

The Scientific American Digest

A Review of the Newest Developments in Science, Industry and Engineering

CONDUCTED BY ALBERT G. INGALLS

New System Controls Machinery by Sound

A NEW system of supervision and control by which operator-less machinery can be called up on the telephone and asked questions and given instructions, was demonstrated recently at the offices of the Westinghouse Electric and Manufacturing Company, in New York.

"This system, which is called the 'televocal' system, represents the latest step in the automatic operation of distant machinery," said R. J. Wensley, Westinghouse engineer, in explaining the device of which he is the inventor.

"By means of it, not only can a load dispatcher of an electric power company or street railway call up on any telephone unattended power plants or substations, receive reports on the status of every machine in the station, and start or stop machines, open and close switches, and perform other operations at will, but even the housekeeper could direct the operation of her home from the club or whist party.

"Automatic operation of electric machinery has been in use for several years, but all systems now employed require special wires run from the supervising point to the station. Where stations are many miles away, numerous such installations may be very expensive. Telephone connections to all points always exist, however, and by using these lines for supervisory control, the cost of the control system is greatly reduced.

Underwood and Underwood

The inventor and the receiving end of the "televox," showing the relays that control the machinery which does the desired work

"It is against the rule of the telephone companies to connect extraneous wiring to the phones or to transmit over their lines anything except sounds within the register of the human voice," said Mr. Wensley. "Hence, to utilize the telephone for controlling machinery, these regulations have to be observed. The problem was solved by using a series of sound-sensitive relays to make the switching connections at the control end, and operating these relays by telephoning to them different combinations of musical notes.

"It is theoretically possible to construct sound-sensitive relays that will respond to spoken words," continued Mr. Wensley, "and to prove this point, we have at our East Pittsburgh laboratories a door which will open to the call of 'Open, sesame!' and to no other combination of sounds. However, such a system would be highly complicated to work out in practice, whereas by the use of only three notes of different pitches, we can secure any combination of operations desired."

The operation of the televocal system, or televox, as demonstrated by Mr. Wensley can best be understood if one were to listen in on a housekeeper at her club calling her televocally equipped home. She has three small pitch pipes, each giving a different musical note, and by means of these she asks questions and gives orders after being connected to her home.

HOUSEKEEPER to telephone central: "Give me 1234 Greenhill, please."

Operator rings that number.

Televocal system lifts receiver when telephone bell rings and housekeeper hears in her receiver a special combination of buzzes which is the signal from the televox that the right number has been rung.

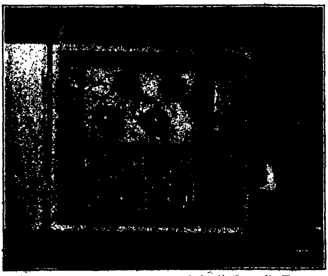
HOUSEKEEPER, with pitch pipe: "Peep!" which means, "Hello, get set for action."

TELEVOX stops buzzing signal and sends out a series of clicks, meaning "All set, what do you want?"

HOUSEKEEPER: "Peep, peep, peep," which means, "Connect me to the oven of the electric stove."

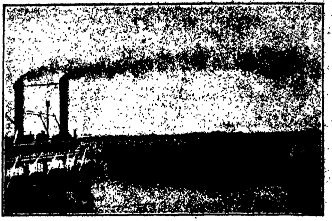
TELEVOX: "Buzz, buzz, buzz——buzz-z-z-z-z—"—"You are connected and the switch is open."

HOUSEKEEPER: "Toot!" which means "Shut the switch and start the oven."



...mitting component of the "televox." Tun- ...e essential parts of the apparatus. These will vibrate only in response to their pitch

Commanding the "televox." The operator is pressing various buttons which actuate their respective tuning



A Mississippi River steamer pushing four barges. Each one of these barges carries 36,000 barrels of oil, or more than a million and a half gallons

Loading the huge barges with oil. Unlike most cargoes, oil may be pumped aboard and discharged at the destination by the use of the same method

TELEVOX stops the long buzz, which was the signal that the switch is open, closes the switch, and then gives a short, snappy "buzz" to indicate switch is closed.

HOUSEKEEPER: "Peep, peep, peep, peep," which means, "Connect me to the furnace and tell me how hot it is."

TELEVOX: "Buzz, buzz, buzz, buzz—— buzz, buzz"—Four buzzes mean, "You are connected to the furnace;" two following buzzes mean, "It's pretty low."

HOUSEKEEPER: "Peep, peep, peep, peep, peep"——"connect me to the draft operating switch."

TELEVOX gives five buzzes and then a short one, meaning, "You are connected to the furnace draft switch and the drafts are closed."

HOUSEKEEPER: "Toot!" or, "Open the drafts!"

TELEVOX opens the drafts and gives a long buzz, "The drafts are open."

HOUSEKEEPER, blows her third pitch pipe, which means, "Good-bye."

TELEVOX hangs up receiver.

This series of operations was explained by Mr. Wensley as follows:

Sounds that come over the telephone to the televocal apparatus are received from the receiver by a sensitive microphone, and the buzzing signals made by it are given out by a loud speaker close to the telephone transmitter. Hence, no electrical connections to the telephone are needed, and nothing but sound is received from it or given to it.

When the bell rings, a sound-sensitive relay lifts the telephone hook, starts up the station-signal buzzer, and sets the whole apparatus ready for action.

By means of a high note (produced at the demonstration by an electrically-operated tuning fork) any desired one of any desired number of relays is brought into play. By sounding the note twice, relay number 2 is connected; by sounding the note three times, relay number 3 is connected; and so on indefinitely. The operator must, of course, know his relays, and call for the particular one desired.

Suppose he calls for number 3, which is one that will open or close a certain circuit breaker. When this relay is connected in circuit, the televocal device gives three [illegible] umber 3 relay is [illegible] a long buzz or a [illegible] g the circuit breaker it [illegible] r open or closed, as the case may be.

Then, with everything set, the operator sends out a note of a lower pitch, called the "operating note." This causes the relays to act so as to reverse the condition of the breaker, closing or opening it, as the case may be, and reporting the fact by changing its long buzz to a short one, or vice versa.

If the operator calls for a relay that is connected to a water level device or a thermometer, the relay, when connected, will read off the water level or temperature by an appropriate number of buzzes. Then by calling for another relay, the operator can cause whatever action may be needed according to the information he has just received.

In this manner, almost any desired information can be secured or operation performed.

The sounds when received by the televocal apparatus are passed through filters so that all but exactly the selected pitches are eliminated and extraneous noises are prevented from causing operation of the relays.

If the televocal system is called, it will repeat its buzzer signal for about a minute and then hang up unless it receives the special high-pitched note that is the signal it is wanted and should set itself for operation. Hence, if called by accident, it will hang up automatically after a minute's buzzing without taking further action.

When called into action, it will keep the circuit open indefinitely until it receives a special low-pitched note, which is the "good-bye" signal and causes it to hang up and go out of action.

Under ordinary circumstances, mechanically-operated sound-producers are employed, but a musically gifted operator can secure information from the televox by whistling or singing at it.

Distance is no barrier to the operation of the televocal system. An operator in New York could control machinery in San Francisco, Cuba, and England—the transatlantic radio link being used in the last instance.

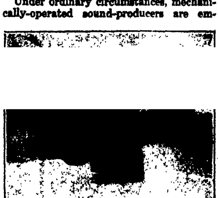
The telephone instruments employed are not altered in any respect and may be used in the ordinary way whenever wanted.

Modernizing the Mississippi

ALTHOUGH public attention has recently been centered on the Mississippi River, little has been published concerning some lines of modernization which are rapidly affecting the old manner of handling traffic. Caterpillar tug-boats, modern rust-proof steel barges, and more recently enormous oil barges are some of the latest trends.

The development of the oil fields in Texas and Oklahoma has added another line to steamboat traffic on the Mississippi. Oil shipments on the great inland waterway are made in tank barges—flat-bottomed boats of large capacity. A single steamer—in our illustration it is an old type stern paddle-wheeler—pushes four loaded barges, each with a carrying capacity of 36,000 barrels. Thus one tow will transport more than a million and a half gallons of oil.

The barges are loaded and discharged by pumps installed aboard the barges, so that the conveyance of the cargo is very "flexible."



This unusual type of revolving fire-hose nozzle for fighting ship fires is described at the right

To Fight Unseen Fires

IN firefighting, one of the most tricky and difficult fires to reach is that between decks or in smoke-filled cellars.

To meet this situation, the Heffernan Multiple Nozzle Distributor was designed and has proved so efficient that the designer received the New York Fire Department administration medal for 1926.

Six smooth-bore nozzles set in a circle, equi-distant on the horizontal plane, with each nozzle placed at a different angle in a vertical plane, freely rotate together around the axis of the hose coupling. This provides that every point within reach of the stream will be covered in an upward circular direction; the water falling from these streams extinguishing the fire below. Two other five eighths inch nozzles can be elevated or lowered to regulate the speed of rotation of the distributor; for, to be efficient it has been found that the nozzles should revolve slowly in order not to break up the streams. Thus, larger streams can be thrown greater distances. The distribu-

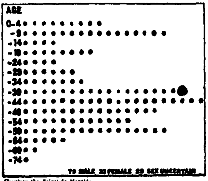
or is lowered into the fire area by the hose which attaches to the coupling shown.

It is estimated that, siamesed to two pumping engines, at 150 pounds pressure, from 1200 to 1400 gallons of water per minute can be discharged and an area of 4,500 square feet can be covered.

Do We Live Longer Nowadays?

THE popular belief that "in olden times people lived to a ripe old age, while nowadays they die at a younger age," is blown sky high by some interesting research performed by Prof. T. Wingate Todd of Western Reserve University, and described in the *Scientific Monthly* (New York). The evidence of ancient burial places, in the form of the actual skeletons of the deceased of various periods, demonstrates clearly that in spite of the widespread notion to the contrary, relatively few people formerly lived to be old, and that even in our day among primitive tribes, despite what some imagine is "the normal healthy life of a savage," most human beings fail to live past the 40 year mark.

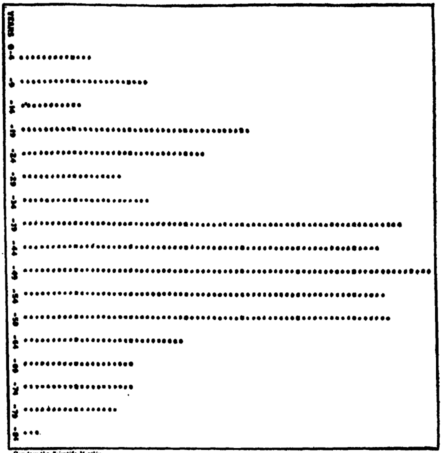
Having gained permission to excavate



Courtesy the Scientific Monthly

Mortality graph based on skulls and skeletons from a medieval English community. The dot representing median age is encircled

in an ancient burial place, the modern anthropologist has little more difficulty in determining the age at death of each skeleton encountered than the horse trader has in judging a horse's age from its teeth. The bones of the human body undergo constant change, not merely during the long period of growth but through-



Courtesy the Scientific Monthly

Mortality graph based on estimates of remains from Pecos site in New Mexico. Here there was evidently a chance to survive longer, as indicated by the number of remains of individuals ranging from 39 to 59 years of age

out the remainder of life. Explaining how the estimates are made, Prof. Todd writes:

"The life history of the skeleton from adolescence to senility can be outlined in the following manner:

"From adolescence to the age of 25 years, union of epiphyses is the dominant feature.

"From 25 to 30 years, closure of sutures continues the tale along with the consolidation of areas, like the symphysis pubis, which possess rudimentary epiphyses.

"From 30 to 35 years, the skeleton is at its prime and there is a lull in differentiation. Sutures not yet fully closed mark time, having lost their impetus to unite. During this period the muscular system and the cerebellum, the coordinating mechanism for muscular control, begin to show deterioration.

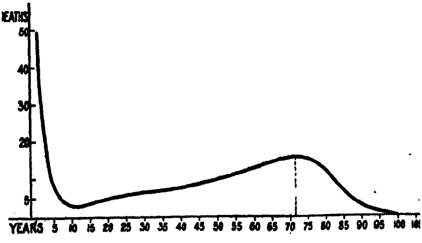
"Such deterioration becomes indicated in the bones between 35 and 45 years, as an intensification of the sites of muscular attachment and as the formation of rims, not lipping, at the articular margins. The so-called muscular markings on bone are not an indication of muscular development and strength but appear when the muscular system is on the downgrade, long after the time when current hypothesis would call for their maximum development.

"From 45 to 50 years, preparation is being made for the far greater changes occurring after 50: the final rims are developed and the smooth and polished surface texture of earlier years begins to give place to a more granular appearance which after 50, first in ribs and vertebrae but later spreading to all parts of the skeleton, is associated with a peculiar modification of bone substance which we describe as a cinder-like texture.

"Between 50 and 60 years, the surface erosions progress, but from 60 onwards they may be more or less stationary although the cinder-like texture becomes more pronounced."

Given, then, an authenticated and representative collection of skeletal remains of any known period of history or prehistory, the anthropologist can deduce considerably more about living—and dying—conditions in that period than might at first thought be supposed; the study constitutes, in fact, a sort of "posthumous census" of the particular age in question.

Professor Todd's first example is not, however, from skeletal remains themselves,



Analysis of the curve of death of 1000 modern English males. This curve brings out the "peak of old age death" which comes at about 70. We do not live longer now than many formerly did, but a far larger proportion of us now live to be old. Statistics must consider high infant death rates

but from gravestones. In a Roman colony of the early Christian centuries these stones, still in existence, were marked with the birth and death dates of the deceased. From this evidence and from some gathered in Africa and Spain, it has become obvious that in the days of the Romans, the peak of the deaths took place as early as between the ages of 20 and 30.

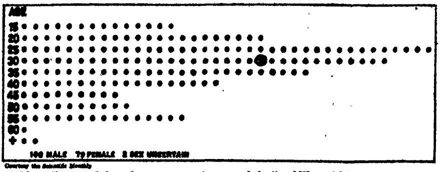
Professor Todd next shows that modern dissecting-room material, representing in the main a class of people who are denied the security of life and comfort of living characteristic of our civilization, live to the median age of 45 years—nearly 20 years longer than the Romans mentioned above; negro material of the same sort runs only to 33 years, due to the fact that death among negroes, even in civilization, occurs relatively early in life.

A large collection of West African negro skulls of modern date gave the results shown in an illustration reproduced in these columns. The median age indicated by the circle surrounding one of the dots falls at 30. Likewise, a collection of the skulls of Tasmanian aborigines—a most primitive race which is now extinct—shows that "the majority of deaths took place about or before 25 years."

Next, Dr. Todd examined the remains ... ...e skeletons exhumed from a Bronze Age burial place in Great Britain. The evidence is that these people's age at death ranged from 17 to 30 years, none being older than this!

Coming up to the Middle Ages—the 11th, 12th and 13th centuries, with 143 skeletons from a cemetery in England—a figure here reproduced shows 39 to be the median age and indicates the existence of no peak of old age, such as may be found today in civilized communities. "We must conclude," says Prof. Todd, "that few individuals reached advanced years."

Next, from a superb collection of 594 skeletons excavated at Pecos, New Mexico, by Dr. A. V. Kidder, covering a range from 800 A.D. to 1800 A.D., it becomes evident that while the median age was in the early forties, old age showed no peak as it does today. Over the thousand years represented by this series, there is no indication that life to old age was anything but an exception.



Courtesy the Scientific Monthly

Mortality graph based upon age estimates of skulls of West African negroes. Each dot on this chart represents skull of an individual; circle, median age

Such is the evidence from which Prof. Todd concludes that "the peak of old age death, so prominent in modern mortality curves, fades into insignificance the further we recede from the present day, and in the dimmer records of the distant past we find no real indication of its existence." The chief difference between ancient as well as modern primitive populations and civilized populations of today, he states, "is the apparent fact that the peak of old age death is a comparatively modern achievement resulting from the greater safety and improved conditions of living."

Horses That Wear Spectacles

SPECTACLED horses that run faster and more consistently than their rivals may soon be a common sight at race tracks, since a method of testing the eyes of race horses and fitting them with eye glasses has been worked out by Dr. Ernest E. Emons of Akron, Ohio.

No horse can make use of the vision charts which the oculist uses for testing human eyesight, so Dr. Emons devised a way of testing their eyes by means of a powerful light and special instruments. The results of hundreds of examinations revealed that approximately 10 percent of all race horses suffer from defective vision.

Once the eyes of a horse are tested, lenses are ground according to the requirements of its eyes, and are mounted in special blinders, as shown in one of the accompanying illustrations.

Extensive experiments were carried out at the E. R. Bradley stables at Lexington, Kentucky. Several horses with faulty vision were equipped with glasses. The animals did not object to the strange device strapped over their eyes. Instead, they immediately gave indication of being able to see better. Tests showed that the glasses served to reduce their running time an average of one second for each quarter mile. In some cases a reduction of nearly three seconds was made. Horses which were formerly so nervous as to be hardly mountable, and which could see scarcely three feet, were rendered gentle by spectacles. The most important result, however, of the newly developed method of testing vision is not the fitting of glasses, as Dr. Emons points out. Instead, the proper diagnosis of trouble will permit the breeding of mounts in such a way that poor vision, which is hereditary in horses as well as in man, will not be transmitted. Eventually this should result in the development of a better class of horses.

A problem of national defense is also involved in this interesting work. Cavalry horses must be as perfect as possible, but in the past practically no attention has been given to the condition of their vision. For greatest efficiency, each horse should have nearly perfect eyesight. Careful breeding with a knowledge of the condition of the eyes will, it is believed, result in a superior brand of cavalry mounts.

The fitting of glasses to horses recalls similar experiments tried several years ago with athletes. At first the idea was not accepted very enthusiastically by the sporting world, yet many of the outstanding athletes of our day have won their laurels largely as a result of wearing spectacles to correct the ocular faults which would otherwise have rendered them relatively unfit for athletic competition.

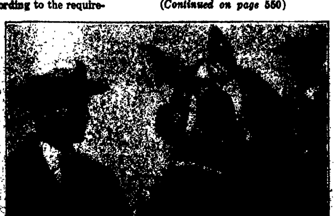
Record Mineral Find Likely to Lower Price of Borax

BOTH borax and the variety of glass known as "Pyrex" are likely soon to become much more common owing to the recent discovery in California of a very large natural supply of a borax-bearing mineral called "rasorite."

Although "Pyrex" is a trade name, everyone now knows about it, especially because Pyrex glassware is regarded by most housewives as superior to ordinary

(Continued on page 550)

Dr. E. E. Emons testing the eyes of a race horse with a special ophthalmoscope he has devised



A race horse equipped with glasses which were designed after tests had been made by Dr. Emons

Learning to Use Our Wings

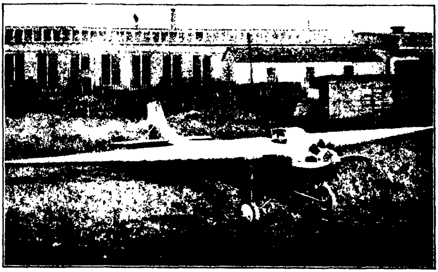
This Department Will Keep Our Readers Informed of the Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York City

All-Metal Cabin Plane

SMALL commercial airplanes are being built in increasing numbers all over the United States, particularly around the famous Wright "Whirlwind" engine. Just as is the case with automobiles of the same horsepower and for similar purposes, such planes tend to a family resemblance. Witness the Bellanca monoplane, the Ryan monoplane which Lindbergh used, the Stinson *Detroiter*, and the Fairchild *FC-2*. The Hamilton cabin monoplane, recently tested out, belongs to the same class of craft, being equipped with the Wright "Whirlwind" engine and carrying four passengers in addition to the crew. However it offers many departures from what is almost accepted practice for ships of this size and purpose.

It is built entirely of duralumin, v t thin sheathing of the same metal, a s one of the smallest planes ever bu t the United States embodying such - struction. The bracing struts from t : fuselage to the monoplane wing are c - pensed with. Instead, the wing is made) taper from root to tip, in both plan a l elevation. At the root there is, theref , a very deep and wide wing section to tal) up the heavy bending moments. Instead of the customary two spars inside the wing, running along its span, three spars are employed. While this makes the structure somewhat more difficult to calculate, it also gives the possibility of lighter construction than with two spars.



A view of the all-metal monoplane described in these columns

In the mounting of the engine, the designer seems to h

spinner so that the bow of the ship presents a well streamlined appearance. The two 40-gallon tanks are placed in the wings on either side of the fuselage, well out of the way of the engine in case of a crash, and high enough above the carburetor to give pure gravity feed. The constructors have frankly gone to a very wide (nine-foot) tread, useful in preventing sideways tipping on the ground. Shock absorption is provided by two struts which go vertically up to the wing, with shock energy taken up by rubber disks in compression.

In the passenger and pilot accomodation, some interesting points emerge. The cabin windows are in the wing stub instead of the side of the fuselage. The wing stub is so built into the upper portion of the fuselage that the cabin is eight feet wide above the seats of the four passengers. With an arm rest, the occupants thus have unusual comfort and elbow room. With the very deep wing at the center section, the fuselage disappears partially into the wing itself. The streamline enclosure for the two pilots is itself streamlined to wing contour. There may be aerodynamic advantages in such design. The inclusion of dual control is valuable for all around purposes. In rear of the passenger cabin is a compartment of 70 square feet in which mail or freight may be carried.

The specifications of the plane are span, 48 feet, five inches; length, 31 feet, five inches; height, eight feet, three inches; weight empty, 1858 pounds; useful load, 1200 pounds; maximum speed, 120 miles per hour; landing speed, 48 miles per hour. Altogether this is a very useful plane for use in connection with airmail feeder lines and for taxi work.

Herbert Photos

...ful method of delivering typewriters by airplane has been demonstrated at Curtiss Field and other airports. Three Royal Typewriter machines, carefully packed in a large case, were released from a Ford-Stout all-metal monoplane as it flew over the field, and were wafted gently to the ground, via parachute. This may suggest an idea for clever advertising, but there is no reason why the delivery of various commodities should not be expedited by the airplane, coupled with a parachute

Bonney's "Gull"

— timer in the aviation game. He was taught to fly by Orville Wright in 1910, and has been flying ever since as a test pilot and civilian instructor. Of an inquiring turn of mind, he caught sea gulls, made plaster casts of their wings, and after two years of work has produced a machine on very unconventional lines. The flight tests have been delayed by engine troubles and other difficulties. They are being awaited with considerable interest. Opinion is divided as to whether the new machine is a hopeless freak, or a real step forward.

One of Bonney's aims is to produce a craft which will land with a short run. By a hydraulically operated mechanism, he is able to change the angle of incidence of the wings (as shown in the photograph) on landing, so that all the lift, or most of it, is lost and a maximum resistance is offered to forward motion. At the same time, since the lift is lost, the full weight of the plane rests on the ground and the wheel brakes are rendered more effective. The resistance of the wings balances the resistance of the brakes so that any nosing-over tendency is avoided. In any case, the provision of a third wheel at the tail instead of the conventional tail-skid enables the center of gravity to be placed back of the front wheels, which in itself should prevent nosing over.

The brakes can be applied simultaneously or separately on either wheel; in con-

junction with a steerable third wheel perfect control in "taxying" should be obtainable. By a further application of hydraulic control, the wings can be swung back as well as down—in other words, the wings can be "folded back" rapidly, so as to park in a hangar only 15 feet wide. The rear part of the wing is hinged relatively to the front part and the camber or curvature of the wing varies automatically.

At high speeds the curvature is small, so that the wing profile is a high speed one; at low speeds the curvature is large, and the lifting capacity is increased accordingly. This automatic variation in camber is the feature which we would question the most. The profile and plan form of the wing is such as to be extraordinarily efficient, the shape of the tips seems to be such as to decrease end losses. There are no ailerons such as we are accustomed to see. The outer portion of the wing on either side can swing into the fixed portion and back, (see the underside of the front view of the craft). This lessens the moment arm of the outer portion, and lateral control results.

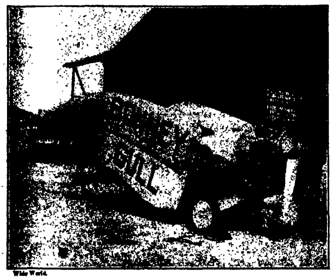
Possibly such an arrangement may remove the tendency of the usual ailerons to wing a machine off its course. The portion which swings back will lose efficiency by the breaking of the plan form, and so the resistances on either side should balance.

Further, with ordinary ailerons and at high angles of incidence, there is loss of control. When the front part of the wing is at a large angle, turning down the aileron does not produce the desired increase in lift, and control is lessened thereby. In the *"Gull,"* when the outer portion is turned back, control will always remain, no matter at what angle the wing surface is inclined to the wind. The elevators may be spread in flight by the pilot, as a blackbird "fantails" while on the wing. This has the advantage that it may be possible to alter the stability characteristics of the [illegible] at will. The chassis is worthy of [illegible] It is entirely of the cantilever type, no wires or struts exposed. See [illegible]par- ration above.

[illegible] to think that Bonney has [illegible] lines, and that his ob- [illegible] Whether the co[illegible] will be success- [illegible] such complex- [illegible] in actual practice,

Wide World

Left: Side view of the new bird-like plane, with wings in flying position



Wide World

Right: Showing how the wings of the "Gull" are folded for parking

The Operator's Viewpoint

THE Western Air Express operating between Los Angeles and Salt Lake City is one of the best operated air lines in the United States and is said to be making real profits. The views of its able president, M. Hanschue, as expressed in a recent paper on "Commercial Aviation From the Operators' Viewpoint," are therefore authoritative. These views are particularly timely when so many new air lines are in process of organization.

The airplane, as a transportation vehicle, has limitations. At present it has little value save where it serves two major communities separated by distances not traversed by a slower and cheaper medium overnight. An exception to this rule is afforded where two communities have overnight train service, but where the airplane can relieve emergency traffic and give special service by a round trip in the course of one business day.

Regularity of performance is essential above everything else. The regularity of performance of American air lines now ranges between 90 and 99 percent or more. But only where mechanical performance is at its highest is steady patronage by the public assured.

Modern equipment is excellent; far better than is generally assumed to be the case. But planes selected for a given route must have sufficient reserve of power to fly under all conditions without being forced to their physical limit. Furthermore, there must be a sufficient reserve of aircraft to meet all contingencies.

The present rate on airmail to the user is 10 cents per half-ounce or fraction thereof; that is, $3.20 a pound anywhere in the United States. This blanket rate is arbitrary but, presumably, it yields the government an average between the long and short haul, and between bulk mail and letter mail sufficient to pay the airmail contractors. The lightweight letter mail generally runs 40 to 50 letters to the pound, and therefore yields four to five dollars per pound to the government. Express matter would be quite expensive to the user if it had to yield the same amounts per pound as the mail, and it is doubtful whether passengers could pay rates equivalent to the carriage of mails. Ultimately, the operator's business will be a combination of mail, express, and passengers. For the time being, the mail looms very largely in his calculations.

The Post Office Department under the Kelly Bill can grant contracts for air mail, but at the same time it is obliged to ask for bids. The tendency nowadays is to bid dangerously low. The low bids come, not from experienced companies, but from new entrants into the field. From such low bids, a serious danger will arise to the entire industry.

Mr. Hanschue advocates very wisely that the Post Office should not let contracts at a price which will not return revenue sufficient to maintain adequate operation. We heartily agree. Some companies are even now showing dangerous and continued losses. It also follows that the Post Office Department should not yield to local pressure and ask for bids over routes where geographic and economic conditions are such as to preclude a reasonable volume of business.

The organization of an air line should be preceded by a serious and unbiased survey. It should be determined whether the route presents any serious natural barriers—under the headings of topography, weather and air navigation facilities. The type and size of airplane best suited to the proposed operation; the number of planes required to maintain a high standard of service; the costs of operation; depreciation; the costs of insurance coverage; all these factors must be carefully considered. Above all the possible volume of traffic must be studied.

Hanschue has some wise words to say about financing. "Original financing should provide a reasonable cash surplus above actual costs of installation. There should be no promotion stock issued nor any commission paid on stock sales."

Personnel should be selected on ability rather than on a salary basis, for only expert pilots and mechanics can be employed if there is to be hope of success.

There arises in air line economics an interesting financial point. A [illegible] air line has a c[illegible] tion of its [illegible] cost. It [illegible]

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INDUSTRIES FROM ATOMS

A Department Devoted to the Advancements Made in Industrial and Experimental Chemistry

CONDUCTED BY D. H. KILLEFFER

Mechanical Improvements in Drug Manufacture

POSSIBLY many of our readers remember the old nursery rhyme which goes in part as follows:

Miss Mehitable McFlimsey
Had a very funny whimsy
  Of crying when she had to go to bed
Said the Bed, "It is a pity
To see you crying 'Hitty,'
  So after this I'll come to you instead."

An adaptation of the idea of Miss Mehitable McFlimsey's bed has been applied to the manufacture of drugs. In the plant of the Eli Lilly Company, Indianapolis, the constant moving of supplies around the plant has been done away with by mounting on a continuous conveyor the percolators in which fluid extracts are prepared. The operator is stationary at a point where all the supply lines converge and the gigantic percolators over which he has supervision are moved about in an elephantine procession, to be charged and discharged as required. Other mechanical improvements have greatly reduced the labor requirements and the chances of error in drug manufacture in a recently built addition to this plant.

X-Ray Studies of Lime

THE application of the modern developments in the use of X rays in crystal analysis may lead to valuable results in improving the quality of lime used in plastering. A study of this field was reported to a recent meeting of the American Chemical Society by Dr. Marie Farnsworth of New York University, who found that X-ray methods may be depended upon to furnish accurate data as to the plasticity of lime samples. Dr. Farnsworth found that the ideal lime from a plasticity standpoint is produced by burning marble in a vacuum. An X-ray spectrograph of a sample of this lime is shown in the accompanying illustration. By comparing X-ray spectrographs of lime as manufactured with an ideal of this kind, it may be possible to improve greatly the quality of the output of the plant.

A New Metal Cleaner

IN manufacturing para-dichlorobenzene, large quantities of its undesired brother, ortho-dichlorobenzene, are produced. Although the para compound is required both by industry and as an insecticide and fungicide, the ortho compound has found very little use. It is necessarily produced to the extent of about a million pounds a year and hence the finding of a profitable use for it is important.

Messrs. Groggins and Scholl of the Color Laboratory of the Bureau of Chemistry have been studying the problem of utilizing this unwanted material and have found it to be an excellent solvent for the tarnish on most metals. The material is very cheap and readily dissolves the oxides making up the tarnish on copper, silver, and nickel. It may be used as produced or it may be mixed with mild abrasives such as chalk to make a paste of it for use in the home. The investigators carried out experiments with a liquid cleaner containing one part of chalk to five parts of ortho-dichlorobenzene and obtained extremely satisfactory results in polishing metals with it. The material does not attack the metal itself.

New Primary Cell

THE Swedish chemist H. D. Nyberg has invented a primary cell involving some new features. In this cell porous carbon is used as the container, acting at the same time also as a depolarizing electrode. The carbon is impregnated with paraffin wax in such a way that it is completely impermeable by the electrolyte but allows the diffusion of air through its pores in sufficient amounts for depolarization. The electrolyte is mainly a 10 percent solution of sodium hydroxide, and the soluble electrode is zinc amalgam containing ½ percent of mercury. The Swedish Junger Storage Battery Company, which has obtained a license for the exploitation of the patents in all countries except America and Australia, has started the manufacture of the new batteries.

Synthetic Clothing

MODERN woman would not be disturbed at all if the supply of natural textile fibers were entirely cut off, according to Prof. Pauline B. Mack of the Pennsylvania State College, addressing the Institute of Chemistry of the American Chemical Society at State College, Pennsylvania.

"The creative chemist has produced synthetic fibers suitable for the produc-

X-Ray spectrograph of lime produced in a vacuum at 1800 degrees, Fahrenheit

tion of textile fabrics of unusually artistic beauty," Mrs. Mack said, "and dresses for every conceivable occasion can be made entirely of manufactured substances. By placing these artificially produced materials on the market at low prices, more has been done toward making a democracy of all peoples of the world than by any other single agency."

During the course of Mrs. Mack's lecture, Miss Elizabeth Wagner of Morgantown, West Virginia, a member of the Institute of Chemistry, was presented as a model of a modern bride "clad from head to toe, except for the soles of her slippers, in synthetic materials." "Her dress was made of rayon fibers, trimmed with rayon lace," Mrs. Mack said.

"The sleeves are of cellulose acetate fibers. Her tulle bridal veil is a nitrocellulose product. The orange blossoms are precipitated calcium carbonate coated with paraffin. Her stockings are of rayon. Her slippers are of rayon and metal threads, the metal a tin-copper alloy. Her beads are made of collodion with fish-scale essence as the iridescent material.

"Her prayer book has a celluloid back (made from collodion and camphor) and the paper and ink are both chemical products. Even the traditional garter, embodying 'something old, something borrowed, and something blue,' is made of rubber rendered adaptable by chemical treatment, covered with rayon and ornamented with rayon and metal roses. It is an interesting note in this connection that this entire costume cost less than 25 dollars.

"And as for the remainder of the bride's [illegible] has an unlimited number [illegible] textile fabrics from which [illegible] rayon velvets, rayon fabrics for sport [illegible] color effects made by [illegible] rayon with different [illegible] and dresses and shawls embroidered with lustrous rayon threads, [illegible] of rayon, of rayon plush, or of cellophane, beads of collodion, of glass, of casein, or of bakelite; all these and more are easily to be had."

Is Ethylene a Ripener?

SOME time ago in this department Dr. R. B. Harvey, of the University of Minnesota, was quoted as stating that "unripe fruits could be quickly ripened at will by exposing them to an atmosphere containing a small proportion of ethylene." Investigations carried out by Messrs. Chace and Church of the Laboratory of Fruit and Vegetable Chemistry, United States Bureau of Chemistry and Soils, Los Angeles, tend to disprove Dr. Harvey's conclusions. These investigators have carefully studied the effect of ethylene on citrus fruits, dates, persimmons, bananas, tomatoes, pomegranates and avocados and find that while the color of the fruit is affected, none of the changes ordinarily connected with ripening are observed. The astringency of green persimmons is destroyed by exposure to ethylene in concentrations of one in 5000 of air, but no other changes in the edible portions of the fruits were found.

Courtesy of the Chemical Construction Company

[illegible] trogen used in sulfuric acid manufacture. This small plant has replaced a much larger one that used Chilean nitrate for the same purpose, and is saving money for its owner. In the photograph, the numbers indicate the following parts: 1, Air filter; 2, Blower; 3, Mixing cylinder (convertible to stripping tower for aqua ammonia); 4, Filter for mixture; 5, Preheater for mixture and ammonia; 6, Converter; 7, Pyrometer; 8, Flow-meters for ammonia and mixture; 9, Air control valve; 10, Ammonia control valve; 11, Ammonia storage pressure gage; 12, Pyrometer alarm

Synthetic Methanol

TWO new processes for the synthesis of methanol using by-product gases as raw materials have recently been put into operation in this country. The processes used are similar in some respects to those developed abroad, but new features make them particularly efficient.

The Commercial Solvents Corporation, to utilize a mixture of approximately equal volumes of hydrogen and carbon dioxide obtained as a by-product of its fermentation operations, has developed a process for converting the mixture directly to methanol. Lazote, Inc., is utilizing the methanol reaction to remove carbon monoxide from the nitrogen-hydrogen mixture obtained from the water-gas reaction before using it in the Claude ammonia converters. The increased purity of the gas mixture thus obtained and the value of the methanol produced make the purification a profit-producing operation instead of a mere expense, and thus the cost of ammonia synthesis has been somewhat reduced.

A Cheaper Mechanical Refrigerator

ALTHOUGH there are many types of mechanical refrigerators now on the market and in successful use, frequent announcements are made of new types claiming advantages over those now available. According to a dispatch to the American Chemical Society from Norway, a new apparatus that is both cheap to buy and to operate has been perfected by a Norwegian engineer, Ivar Amundsen.

His apparatus is based on the absorbent power of activated carbon, the cooling substance being methanol or ethyl alcohol. The apparatus is filled only with activated carbon and a limited amount of alcohol under a pressure below the atmosphere pressure, the weight and dimensions of the apparatus being quite small. A refrigerator suitable for a common household will require a heating element of 400 watts and 300 liters of cooling water per 24 hours, having under normal conditions a cooling effect corresponding to 10 kilograms (22 pounds) of ice. A larger type designed for the tropics has a cooling effect equal to a consumption of 20 kilograms (44 pounds) of ice per 24 hours. Scientific and practical tests have been made by Norwegian experts and the results have fully answered expectations. A strongly financed company has been floated under the name of Amundsen Refrigerator Company to take care of the manufacturing of the apparatus and the further exploiting of the patents in foreign countries.

A New Non-Burnable Fumigant

MOTHS and beetles that prey upon clothing, carpets and furniture are to be attacked with a very effective new fumigant devised by R. T. Cotton and R. C. Roarke of the United States Department of Agriculture. These investigators have found that a mixture of three parts by volume of ethylene dichloride and one part of carbon tetrachloride is very effective against pests of this type. The mixture is cheap, non-flammable, nonexplosive, non-injurious to stored commodities, and not dangerous to human life. The toxicity of the mixture is approximately five times that of carbon tetrachloride alone. In reporting their results in the *Journal of Economic Entomology*, these investigators say in part:

"Insects used in the experiments were chiefly the clothes moth, *Tineola biselliella*; the furniture beetle, *Anthrenus vorax*; and the black carpet beetle, *Attagenus piceus*. In one case other insects were used. In these experiments [illegible]

(Continued on page 365)

Applied Science for the Amateur

A Department Devoted to the Presentation of Useful Ideas. Material of Value to All Will Be Found Here

CONDUCTED BY A. P. PECK

Model Airplane Fittings

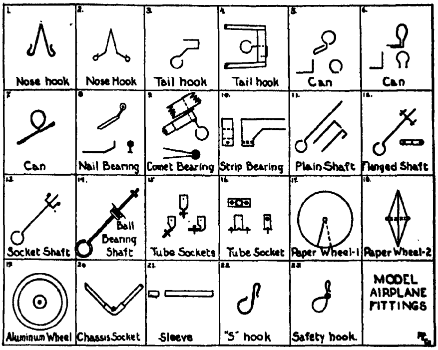
IN our November issue, we announced the publication of a series of articles on the construction of model airplanes, and also gave instructions for the construction of a glider. Before going on with the details of a plane in which a rubber-band is employed, it will be well for the amateur builder to learn something of the fundamentals of model airplane building. Therefore, we present the following paper, prepared by the Playground and Recreation Association of America. By studying this carefully, you will be ready to go on with the construction of a flying model when the plans are published. Do not forget our offer to publish pictures of your home-made models as often as space will permit. Send in your photographs—others want to see what you have accomplished. The Editor.

IN the construction of model aircraft, various fittings are necessary to join the parts of the models together and to operate the pieces of mechanism. These are constructed of pieces of wire, metal, et cetera, which are found in most boxes of odds and ends. In the construction of some models which differ from the usual standards, ingenuity can often be used in making up special fittings, often from articles originally designed for quite a different purpose. The following examples of fittings illustrated in the drawing are typical for all model construction and can be considered either as explicit directions or as general suggestions.

In the construction of scientific models having frames consisting of two sticks open like a "V" and joined at the apex, a fitting known as a "nose-hook" is used at the front, both for joining the sticks and holding the rubber bands which compose the motor. Two nose-hooks are shown, one of heavy and one of light construction. The first type is used where piano wire cannot be procured and it is necessary to use a larger wire in order to obtain the necessary strength. The second type is the kind generally used on the record-making models and is formed of small piano wire of about fifteen thousandths of an inch in diameter. These hooks are made with round-nose pliers. The best procedure is to use a two-inch length of wire in the ends of which hooks are formed, after which the wire is bent in the center to form the "V."

The next fitting shown is a "tail-hook" used on tractor models to fasten the rubbers at the rear of a single stick or frame. It is bent from light wire and the squared portion is made the same size as the stick and bound to it with thread. The next tail-hook shown is the kind used on scale models or tractor frames where the frame itself is used to support the rubbers. As illustrated, the wire is bent back into the tail piece in order to secure it.

The next three squares contain examples of "cans" or rubber guides. These are very important and useful fittings on a model because they are fastened along the sides where the rubbers pass and distribute the strain of the rubber pull. They serve the same purpose on a model that agate eyes do on a fishing rod. They are called cans because, when these were first invented by model makers, they were usually made out of bamboo and were barrel or can shape.



Various types of model fittings described in these columns

The first square shows the kind most commonly employed. It is shown at the top in perspective, and at the bottom a side and end view of it are shown. It is noticed that the large loop of the can is left open. This is often a valuable feature when the model maker wishes to remove the rubbers from the cans while he is winding them, to prevent their abrasion. The next type of can is used on single-stick tractors where it is not necessary to draw the rubbers out of line during winding. The third type of can is the kind made when it is desired to use aluminum wire. The legs are somewhat flattened in order to make them more secure when they are bound on to the stick. This is shown in perspective.

Figure 8 shows a bearing which is used to support the rotating propeller shaft. It is the type most commonly used and can be easily constructed by beating and bending a small wire nail, after which a hole is drilled in the end intended for the shaft. The long part is bound to the motor frame. Figure 9 shows another type of propeller bearing, known as the comet type because the profile view of it resembles a comet. It is formed by bending a piece of strip metal, preferably phosphor-bronze, although tin or brass may be used, around a short length of tubing. The tubing is soldered in place. This type of bearing is used where the model has a rear brace to which the propellers are attached.

The third type of bearing shown in Figure 10 is made from strip metal, preferably a piece of aluminum about one sixty-fourth inch thick, one-fourth inch wide, and four inches long. It is bent to shape as shown in the front and side views and a hole for the shaft is drilled where indicated. In use, the two horizontal pieces are placed each side of the motor stick which extends to the front of the fitting and is bound in place. Some model makers prefer to secure this bearing with small nails or screws.

The propeller shaft is, of course, very important and four types are illustrated in the drawing. Figure 11 shows the plain shaft which is commonly used. In fact, it is the trend among all model makers to use fittings which are both simple and light. This plain shaft is made from piano wire or a similarly stiff wire about one hundredth of an inch in diameter. It is secured in the propeller by bending over the end as explained in the article on propellers. Some model makers prefer to bend the end back into the propeller, but with balsa propellers this is not advisable because of the weakness of the wood.

The next type of shaft shown is used where the model maker is of an experimental inclination and wishes to try different kinds of propellers, making their replacement by an easier method than

straightening the shaft, as is necessary with Figure 11. To construct this flanged shaft, a small flange is soldered to the shaft where shown. The propeller is secured by driving small nails or screws through the flange holes into the propeller hub. Figure 13 shows a type of shaft which is an improvement on the flanged shaft. In this type the flange is elongated and formed into a hook at each end, after which it is bent around the propeller hub. The propeller is secured to the shaft either by a piece of wire surrounding the hub and fastened to the two hooks or by a small rubber band between the two hooks. The type of rubber band that should be used is known commercially as an "election" band. They are about the diameter of a pencil lead. Incidentally, these bands are useful for another purpose which will be discussed under the subject of "S" hooks in a further paragraph.

Figure 14 shows a ball-bearing shaft such as is supplied by commercial model airplane companies for their better class of scale models. Some of the more mechanical model makers make these shafts themselves, but as their construction requires the use of a lathe, it will be necessary for most model makers who prefer them to purchase them. This type of shaft can be purchased for about 65 cents each. Their only fault is their weight.

In the construction of scale models and occasionally in scientific models, particularly where the scientific models have land or water chassis, sockets are used for receiving the ends of struts and cross pieces. These tube sockets can be easily made by taking a small piece of copper tubing and cutting it off to the length desired, after which one end is squeezed together, preferably in a vise. The squeezed portion can be [illegible] left straight or bent at an angle, depending upon the position where the [illegible]. Sockets are fastened to the [illegible] by screws or nails through the tongue, [illegible], which is held in the barrel of the socket, is retained by a small nail [illegible] which a hole is shown in each view. The next view shows another type of socket also made from copper tubing [illegible] in one end and [illegible] to form a base. The copper tubing from which these sockets are made may be purchased at most hardware stores, but in the event that it cannot be secured, the empty .22 caliber rifle shells.

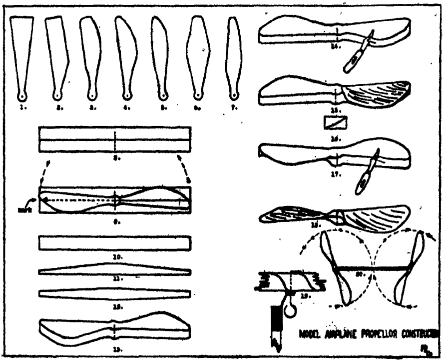
Where models are intended to rise off the ground, a wheeled chassis is usually employed, although skids are sometimes used. A very serviceable wheel may be constructed from stiff paper. As shown in Figure 17, a disk is cut from this paper and a scissors cut is made from one edge to the center. The disk is then slightly cupped like the cone of a radio loudspeaker and the edges which overlap are cemented together. Then, as shown in the next view, two disks are placed together and their edges fastened with ambroid. Passepartout tape with serrated edges can be run around the rim to strengthen the wheel. A small length of copper tubing similar to that used for the comet bearing is cemented in the center to insure smooth running. On the more elaborate scale models, some model makers may prefer to use more ornate wheels. These can be purchased from model supply houses. A type of aluminum wheel having rubber tires and being very attractive can be purchased for 20 cents to $1.25 each, depending on size.

The fastening of the wheels to the chassis is often a problem with model makers. Figure 20 illustrates a possible method for accomplishing this by use of a piece of copper tubing pinched in the center and bent in a "V" shape to receive the chassis struts. The axle is fastened in the crotch of this fitting, using either wire, thread, or rubber bands.

In the construction of scale models, it may at times be desirable to make them so that the wings can be removed from the body. To do this, tube sockets are sometimes used and often a sleeve is employed. This sleeve can be made from thin aluminum sheet bent around the spar of the wing or other wooden member. These sleeves can be purchased from model supply houses also. They are used sometimes in scientific models to enable the model maker to separate his model for packing.

The last two spaces show "S" hooks. These are very useful fittings and are employed on both scientific and scale models where it is desired to unhook the rubber motors from the rear hook in order that they may be wound up with a geared winder. The first type is intended to be constructed from course wire and the second is intended to be made from small piano wire. As will be observed, the second type has the end of the hook turned so that it will engage the shank. This prevents it from opening up under the strain of the rubber pull. On both of these "S" hooks, it will be advisable to use a short length of small rubber tubing to prevent the rubber motors from being cut. This rubber tubing can be obtained either from commercial rubber companies, model supply houses, or from the insulation on electric wires. Rubber bands of the "election" type are useful for fastening the rubber motors and the "S" hooks together. When this is done, the rubbers do not come off of the "S" hooks when the rubber motors are unwound.

It is hoped that the above directions will enable model makers to build their models properly. Every constructor should endeavor to make his model as light as possible and avoid the use of many metal fittings which, although they may add to the appearance of the model, will make it undesirably heavy and detract from its flying qualities.



Steps in making propellers. See text at right

Model Airplane Propellers

UPON the proper design and construction of the propeller depends much of the flying ability of an airplane. In the following paper, prepared by the Playground and Recreation Association of America, many valuable points are brought out. Watch for the publication of instructions on how to build a model plane. The propeller required for the first model to be described is ten inches long. From the article presented here, you can make the propeller, and thus be that far advanced when you get your next instructions. —The Editor.

PROPELLERS are often spoken of as air-screws, and that title explains their use. They are designed to screw their way through the air the same as a corkscrew, when turned, moves through the cork. Of course, air is less dense than a solid substance like a cork, and so an air propeller does not move forward with 100 percent efficiency. The difference between the distance that a propeller would advance in a solid substance and that which it actually advances in air is called the slip. Propellers should, of course, be designed to have minimum slip. Early aircraft propellers slipped as much as 60 percent, but modern propellers are much more efficient and slip only about 20 percent. Model airplane propellers can be made to be very efficient because the wood of the aircraft which they propel is quite light and therefore the propellers are not retarded very much. The model maker should take a tip from this fact and make his models as light as possible, in order that his propellers may exert the maximum push.

Referring to the drawing, it will be noticed that the first seven figures show pro-

(Continued on page [illegible])

Strays From the Ether

A Monthly Review of the Progress Made In All Branches of Radio Communication

CONDUCTED BY ORRIN E. DUNLAP, Jr.

Pooling Intelligence Stabilizes Industry

RAPID stabilization of the radio industry is due in no small part to the benefits derived from association of the leading makers of radio apparatus in an old-established electrical manufacturers' organization, where pooling of intelligence in engineers, in council and in human associations has been firmly established for more than a decade, according to Ray H. Manson, chief engineer of the Stromberg-Carlson Company.

"About five years ago," said Mr. Manson, "it was wisely decided by a few of the pioneer radio manufacturers to affiliate with an established and experienced manufacturers' organization, rather than to form its own group and waste effort in learning how to conduct association matters. At that time, radio was considered electrical in character, the same as it is now, so it was natural for the manufacturing group selected for its affiliation to be the organization then known as the Associated Manufacturers of Electrical Supplies and now broadened in scope and known as the National Electrical Manufacturers' Association—popularly designated as 'Nema.'

"With the smooth running machinery of an experienced organization to handle its routine business, the attention of this newly formed radio group was focused on some of the more important problems of a new and rapidly growing business. For example, it was discovered that radio plugs of various makes would not fit radio jacks of other makes; that cord tips on head sets or loudspeaker cords would not enter the holes provided in radio plugs, or would not go into the openings in the binding posts of the radio receivers; that battery polarity on the jacks of the receiving sets did not always coincide with the polarity of the head sets or loudspeaker; that color-code designation on cords and cables was not uniform, therefore misleading and confusing; that binding posts on batteries did not accommodate any one standard type of connecting cord terminal; that the 'B' batteries of various makes were of different shapes and sizes, so as not to fit into any definite cabinet space; and last but not least, that purchasers demand a large variety of equipment to meet special conditions, most of which could have been avoided by intelligent standardization."

New Amateur Record

FOURTEEN thousand miles covered with a low-power battery-operated short-wave transmitter is the record established by Clair Foster, a radio amateur at Carmel, California. He is now a member of the "Wac," an amateur group known as the "worked-all-continents club." In making the record Foster talked with an amateur in South Africa, using a 201-A receiving tube in his transmitter entirely operated from dry batteries. On the same day he communicated with Shanghai, China, completing the list of continents where his signals have been heard. All communication was done on the 32.2 meter wave, except with England, for which the 20.2 meter channel was employed.

When to Replace Tubes

A RADIO set owner writes: "There is one announcer on the air who in connection with a commercial program is attempting to sell tubes by calling attention to the fact that 'if one tube goes "dead" all other tubes should be replaced for best results.' I am inclined to believe that he should be more specific. One tube may have been in the circuit a year and the others four or five months, or one tube, namely, the detector, controlled by a separate rheostat, may be supplied with more current than the others and naturally it would wear out more rapidly. I can see that if all tubes were in the set for a year that probably better results would be obtained if all tubes were replaced, but he is absolutely wrong when he tries to advertise the fact that if one tube is worn out that the others should be replaced too. What is your opinion?"

You are quite right. If one tire on an automobile is worn out it is no indication that the other tires should be replaced if they continue to give good service. The one tire may have been in longer service, or seen more wear in its particular position and naturally it would blow out first. The same principle applies to vacuum tubes.

But do not forget that a new battery placed in the circuit with others on the decline will wear out much quicker than if all batteries are new. It is not economy to run a new battery with old ones.

THE third edition of the *National Electrical Manufacturers' Association Radio Standards*, September, 1927, is now available. This issue has double the number of standards contained in the second edition of March. The new book contains about 400 standards as follows: 105 general standards, 81 covering transmitters, 100 receiver, 52 battery and socket power, 56 vacuum tube.

Appendices, occupying a total of 43 pages on radio symbols, revised underwriters' rules, Institute of Radio Engineers' preliminary standards and a complete cross index add to the value of the book.

To quicken progress in the radio industry,

Marconi short-wave beam transmitting apparatus being installed at Rocky Point, Long Island

The receiver for short-wave beam transmissions fr England is located at Riverhead, Long Island

various terms have been accurately defined by the standard-making body of the National Electrical Manufacturers' Association, among which is a definition of distortion, defined as "a change in wave form as in passing through a circuit or transmission medium. A wave form may be distorted by (a) the presence in the output of components having frequencies not present in the original wave due to circuit elements having non-linear characteristics; (b) a change in the relative amplitude of the component frequencies due to variation in transmission efficiency over the frequency range involved; (c) a change in the relative phase of the component frequencies. Two or more of these forms of distortion may exist simultaneously."

Photo-radio installation on board the *U. S. S. Texas*. The transmission system employed is that developed by Captain R. H. Ranger

The layman may find considerable amusement in the fact that the radio industry has recently adopted standards defining what the entire industry is all about—namely, broadcasting! Broadcasting is defined in the new standards adopted July, 1927, as "the transmission of music, news, entertainment or other intelligence intended for general reception."

Five-Meter Mysteries

THE five-meter experimental transmitter at station WGY looks like a bird house suspended about 60 feet in the air. The coop is about three feet square. A copper rod about ten feet long projects upward from the roof of the station to serve as the aerial. The signals cannot be heard on the ground but are clearly audible on hills 1 top of high objects in the "line of vision." These short waves act the same as light waves. They seem to travel in a straight line. If a building or a hill intervenes, there is a distinct shadow or "dead spot" on the side opposite the transmitter.

The property of the waves, which enables them to carry messages to tops of hills leads engineers to foresee a possible use for extremely short waves in communication with airplanes. It is believed that the planes could probably pick up the dispatches but if some one on the ground desired to eavesdrop he would have to go up on a hill or on top of a building with a receiving set.

New A-B Unit

A NEW receiver light socket unit, supplying both "A" and "B" power for the set, has been introduced by the Willard Storage Battery Company of Cleveland, Ohio. The device is supplied with a control switch that automatically controls the charging current as the set is turned on and off. A feature of the power unit is a new type electrolytic rectifier that increases the plate potential to 180 volts for the operation of the UX-171 power tubes, and at the same time supplies 40 milliamperes of current, which is said to be adequate for all general receiving conditions. A 135-volt terminal is provided for UX-112 power tube operation. The detector voltage may be varied from 15 to 50 and the amplifier voltage from 45 to 110 by means of adjustable knobs. A 67.5 and 90-volt terminal is also provided.

The "A" portion of the unit consists of a 40-ampere hour, 6-volt storage battery, provided with a charging device that may be regulated between one-half and two amperes. A set of gravity-indicating balls within the glass battery case show the condition of the charge at all times.

De Forest Wins

AN important victory in radio was won by Dr. Lee de Forest when the United States Circuit Court of Appeals at Philadelphia recently held that he is the inventor of the radio feed-back circuit and oscillating audion. The court, in a verdict by Judge Victor Woolle and concurred in by Judges Buffington and Davis, overruled the claims of the government that Alexander Meissner, a German inventor, discovered the feed-back (regenerative circuit) and audion (vacuum tube); those of the Westinghouse Electric and Manufacturing Company that Major E. H. Armstrong was the inventor, and the claims of the General Electric Company that these important radio discoveries were made by Irving Langmuir.

This controversy has been in course of litigation for several years. Dr. de Forest has won four decisions but it is probable that before the issue is finally settled it will be passed upon by the United States Supreme Court.

When Tubes Wear Out

A READER asks, "what takes place in a vacuum tube when it is being aged?" The majority of filaments are of the thoriated-tungsten type. As the tube is used, the thorium is consumed and gradually the thorium, which aids the electron flow, is used up. The tube is then said to be "worn out." In some cases the tubes can be rejuvenated by disconnecting the "B" batteries and burning the filaments slightly above normal brilliancy for about half an hour. There are also devices on the market called "tube reactivators," which operate on much the same principle as this.

WHBL on a Train

RADIO fans who tune-in and hear the waves of station WHBL are in touch with the Pioneer Limited of the Chicago, Milwaukee and St. Paul Railway as it moves along through the Wisconsin countryside at 70 miles an hour.

A steel baggage car is devoted to the radio installation. Sound-proofing the studio and transmitting rooms in the car is given special attention. Part of the transmitting room is enclosed with double sound-proof walls, double plate-glass windows and special doors. This excludes even the sound of the locomotive's whistle.

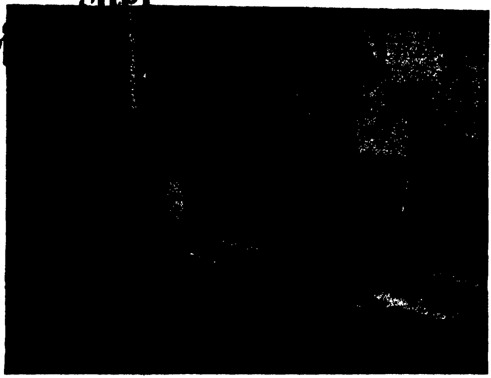
The 70-foot car is divided into four compartments. The first of these contains the power plant. The second compartment of the car has been converted into a transmitter room housing a 100-watt transmitter set using an inductively coupled Hartley circuit, Heising modulated.

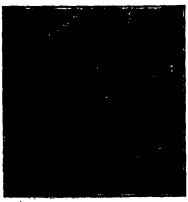
The studio proper, the third compartment of the car, is directly under the observation of the operator through a glass partition. This compartment is treated in the same manner as the studios of the larger broadcasting stations, having the floor padded and carpeted, the walls heavily draped, the ceiling treated for sound, and lighted from the top both by windows and silver electrical fixtures.

The fourth compartment of the car is an entrance hall or ante-room opening out of the rear, providing access from the passenger cars of the train, for the housing of the accessories carried for the operation of the station and for the convenience of the operator and the studio director.

The antenna system consists of a caged antenna and caged counterpoise of equal dimensions carried on opposite sides of the car, the counterpoise being permanently located and the antenna cage being arranged for raising to a height of 60 feet, using a steel tubular mast when the car is not moving.

A wet floor is ordinar slippery floor





That desirable combination—wear resisting and slip-proof effective—are obtained by employing on Alundum Aggregates em-ed in the finish coat of cement.

BUT a Norton Floor in any wet place is practically non-slip.

Take for example this milk station floor—non-slip wet or dry. It is a concrete floor with Alundum Aggregates embedded in the surface.

The permanency of "Norton Floors" and their proof against slipping hazards has been established by installations indoors and out.

NORTON COMPANY, Worcester, Mass.

NORTON

Grinding Wheels
Grinding Machines

Refractories-Floor
and Stair Tiles

The Scientific American Digest

(*Continued from page* 588)

glass for cooking vessels. In the manufacture of this glass a considerable quantity of boric acid is used, and it is indirectly this which confers relative unbreakability to the material.

The reason common glass breaks easily when suddenly heated or cooled is its comparatively high co-efficient of expansion. When cold water or cold air is suddenly directed against hot glass, the outer layers contract first, and if they contract very much before the change of temperature can be transmitted to the inner layers, differential stresses are set up which may cause the glass to break. One way to obviate this difficulty would be to use quartz, which contracts or expands only about one eighteenth as much as glass under a given fall of temperature. But quartz melts only at extremely high temperature; to manufacture it is expensive. Therefore boric acid is added to quartz sand. This acts as a flux, lowering the melting point very markedly, yet producing a glass which has many of the qualities of fused quartz. For these reasons the Pyrex variety of glass is called "borosilicate"—borax plus silica (quartz is one form of silica). While Pyrex is best known to most of us because it is widely used in the kitchen, it is also used in most modern chemical laboratories in place of the more breakable chemical glassware employed until recent years.

The new supply of borax whose discovery is announced below was found in California about 100 miles, as the crow flies, northeast of Los Angeles. To quote from the *Daily Science News Bulletin* of *Science Service:*

"The discovery of some eight million tons of an entirely new mineral all in one huge deposit in Kern County, California, has set a record in modern mineralogy. The mineral is "rasorite," named after its discoverer, C. M. Rasor, leading borax engineer of the Mohave desert field. While new minerals in small quantities turn up once in a while in various parts of the world, it is unusual for so vast a quantity of an entirely new natural chemical substance, and a valuable ore at that, to be so long overlooked.

"Rasorite is known to chemists as the tetrahydrate of borax. As freshly mined, it emerges in striated crystalline bars of glassy texture, some as large as common stovewood. It requires only a recrystallization with an added quantity of water to yield commercial borax, whereas all other important borax ores such as colemanite and ulexite require expensive chemical processes with resulting high prices of the product."

"According to chemical theory, the natural rasorite is a substance which cannot be produced under the ordinary atmospheric pressure of 15 pounds to the square inch, and thus had never been observed either in formations on the surface of the earth or in the synthetic laboratory. Great pressure, due to an over-layer of lime borate and desert sediment, has permitted the formation of the unique compound far below the surface of the Mohave desert. The deposit is located almost on the Kern-San Berna-

ardino county line a few miles northwest of Kramer, California, and thus near the transcontinental line of the Santa Fe to San Francisco. The supply in sight is enough to meet the needs of the United States for over 50 years at the present rate of consumption.

"The market price of borax, already sagging from keen competition among California and Nevada corporations, seems to be headed decidedly downward as the new branch railway line to the rasorite mines nears completion. Borax is used extensively in enamels, welding fluxes, laundry materials, et cetera, but its application in the almost unbreakable borosilicate glass promises the most conspicuous new benefits. At present a few bottles, pitchers, baking dishes and other vessels of this glass are marketed at high prices, but if borax, the critical ingredient, should go below 40 dollars a ton there will likely be a much wider use of the new glass. Borosilicate glass, composed largely of sand and borax, expands but slightly on heating and thus will stand boiling water and even oven temperatures without cracking.

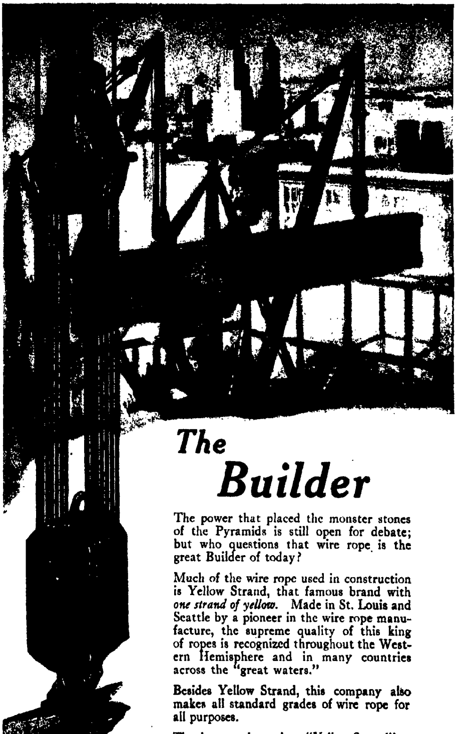
"As now constituted, fruit jars and milk bottles offer a fertile field for improvement. Unfortunately, the manufacturers of bottles will have to be shown why they should make an unbreakable bottle and thus have no opportunity to sell replacements. The dairyman passes on the responsibility for cracked glassware to his deliveryman and customers, and so he has not yet become excited about the matter. However, the casualty list on bottles is enormous, taken the country over. Somebody has to pay the bill, and if the consumers' demand for stronger bottles becomes insistent enough they will doubtless be made."

Scientific Research Underlies Prosperity

A MILK bottle, a display of feminine hosiery and the picture section of a newspaper occupied places of honor on the platform of the New York Electrical Society, when Dr. Harrison E. Howe, editor of the American Chemical Society's journal, *Industrial and Engineering Chemistry*, spoke on "Will Prosperity Continue?"

The present unparalleled prosperity of the United States is based largely, Dr. Howe said, upon the intensive application of the results of scientific research which has been so prominent a feature of recent industrial progress. This was the significance of the milk bottle, the silk stockings, and other articles with which Dr. Howe shared the platform. Time was, Dr. Howe said, when no one except kings or millionaires could possess even a goblet made of glass, let alone anything so perfect as a modern milk bottle. Glass was once suitable only for second-rate, but very ..., strings of beads for feminine ...it. Now it forms the trans... panes of our windows and a ...d everyday household utilities like ...ottles. The change is due, Dr, ...a pointed out, to the gradual accu...n of hard-won scientific facts by ... of the world's scientific in...ts.

The present importance of paper in the world Dr. Howe illustrated by the ... and cheapness of a modern news-



paper. Scientific research has been responsible, also, for converting paper from another of the expensive perquisites of kings and wealthy temples into an everyday convenience for the common man. The legs of our ladies constitute still other living pictures of scientific progress, as Dr. Howe illustrated with stockings made of one of the newly-developed materials which are more than substitutes for silk, because there are some ways in which they actually are better than silk. These new synthetic fibers which science has presented to the world have the advantage of being transparent to the health-giving rays of ultra-violet light, so that stockings made of them admit these essential rays to the living skin beneath.

A piece of colored cloth displayed by Dr. Howe cost, he said, only a few cents. Yet this cloth was dyed with a color even brighter and more beautiful than the famous purple of Tyre, a dye which emissaries of ancient emperors extracted, drop by drop, from a shellfish living in the Mediterranean Sea. Nowadays, thanks to scientific research, even better purple dyes are within the reach of everyone.

One entirely new industry, the aluminum industry, has been created, Dr. Howe said, as the result of modern scientific research. An ordinary aluminum saucepan was an exhibit, he pointed out, of crystallized and concentrated science, for without scientific research, aluminum would be still a laboratory curiosity, not at all the useful metal which it is now.

Dr. Howe cited figures assembled by the National Research Council, indicating that more than 90 percent of the total income of present-day Americans may be traced to the earnings of processes, industries or products which are based upon the results of scientific research.

The "children of research" are as numerous and diverse in modern America our industries themselves. Together with the milk bottle, the newspaper and others, Dr. Howe exhibited samples of the new "duco" varnishes for automobile use, of the synthetic leather called "fabricoid," of the new sugar named "cerulose," of solid carbon dioxide or "super-ice," of the chemically hardened edible fat called "crisco," of the new "electro-rubber," and others.

The continuation of American prosperity will be largely affected, Dr. Howe predicted, by our success or failure in supporting further research work in America and in utilizing its results.

Diet to Make Cure for Hookworm Safe

RESEARCH to make the potent drug that has cured millions of cases of hookworm absolutely foolproof was reported to the American Physiological Society at its recent Rochester, New York, meeting, by Dr. Ann Minot of the Vanderbilt University School of Medicine.

"During the last few years," said Dr. Minot, "carbon tetrachloride has been used more extensively than any other drug in combating hookworm disease, which is widespread in practically all the tropical countries of the world. This drug combines the advantage of being ... with extraordinary effectiveness

and a very high degree of safety. Among the several million cases treated, there have been very few deaths which seem to be caused by the drug used. These fatalities were very puzzling because they occurred only at rare intervals in widely different localities. Much work has been done in an attempt to explain why a drug which may be used with perfect safety in several million cases is capable of suddenly proving fatal in an occasional instance."

Research undertaken by Dr. Minot, however, showed that dogs fed on a well-balanced diet containing plenty of calcium would tolerate large amounts of the drug without harm. But when the amount of calcium was reduced, even small doses of the drug would have an injurious effect which could be cleared up by restoring the calcium.

These results, the woman scientist explained, seem to justify the belief that further cases of carbon-tetrachloride poisoning can be prevented in people by providing the hookworm patients who have not been eating sufficient calcium with liberal amounts of food containing this necessary element before the course of curative treatment is begun.

—*Science Service.*

Handsome Apples Rank Last in Taste

POSITIVE proof that beauty is only skin deep, at least in the realm of apples, was recently demonstrated by an experiment conducted by Roger B. Corbett of Rhode Island State College.

In his test Mr. Corbett took four varieties of apples, peeled them, and cut them into cubes which he placed before eleven different men, ranging from bankers and professional men to farmers and mechanics.

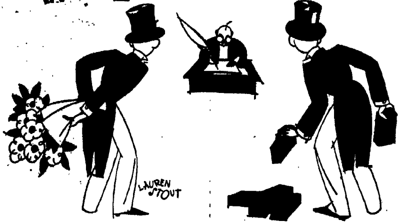
The apple that was rated first when seen whole, shining in its brilliant red skin, ranked last in taste. In the taste test the McIntosh won first place, the Baldwin second, the Rhode Island Greening third and the Rome Beauty last. The Rome Beauty, a dessert apple that is a favorite in stores and on fruit stands, when peeled was found least tasty.—*Science Service.*

Radio No Fertilizer, Experiments [illegible]

[illegible] of barley grow where one grew before, declare plant physiologists of the United States Department of Agriculture, in reply to statements ascribed in a recent news item to Admiral W. H. G. Bullard, chairman of the Federal Radio Commission. Admiral Bullard was quoted as saying that barley planted under the radio towers at Arlington grew so high that it overtopped men walking through it, due to the influence of the radio waves.

Many researches have been conducted in electriculture to determine this very point, the scientists state, and the results have always been either inconclusive or distinctly negative. The Arlington barley, it is pointed out, had no "control." That is, there was no other plot of barley planted on exactly similar soil but removed from the possible influence of the waves. Without such "controls" no biological experiment has any value whatever. In the experi[illegible] of the plant physiologists there were [illegible] "control" plants, which [illegible] no difference from the ones [illegible] *Service.*

IN THE EDITOR'S MAIL



"Franklin Rods"

MANY of our readers will be interested to know that there is at last - ------um where historical exhibits of science and invention can be preserved for all time. The first actual exhibit is referred to in this letter.

Editor, SCIENTIFIC AMERICAN:

Perhaps many of your readers would be interested in knowing that a section of the iron lightning rod which Benjamin Franklin placed on St. Paul's Cathedral, London, England, somewhere about 1770, is now in New York in the Museums of the Peaceful Arts in the SCIENTIFIC AMERICAN Building.

The first lightning conductor ever constructed was set up by Franklin on his house in Philadelphia in the summer of 1752. The use of lightning conductors spread very slowly in the United States, but in 1764 St. Bride's Church in London was severely damaged by lightning. This aroused the authorities so that steps were taken to protect St. Paul's in London and "Franklin rods" were attached to Wren's splendid structure.

About 1770, Benjamin Franklin was called in to advise as to this matter. A ring of iron was fixed around the lantern inside and forced tappings were taken downward from this and passed through openings in the wall, and they were connected with the dome. The cross was connected with the existing metal work by means of a rod of iron. The specimen which is shown in the photograph was taken from a position between the ball supporting the cross and the lead dome. The system of conductors is now very complete and Franklin's iron rods have been displaced by a complete system of copper tape taken from the ball at four different points and carried down at four different points to the earth without any breaks. The authenticity of the specimen now

Clerk of the Work of St.

Yours very truly,
A. I

New York City.

I tion on the subject mentioned in the letter below, we would suggest that they communicate with Mr. Laird.

Editor, SCIENTIFIC AMERICAN:

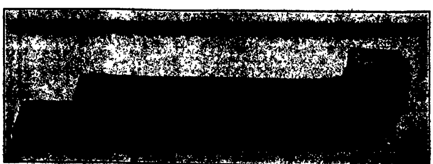
noise in offices and shops.

We would appreciate it if you would suggest to your readers that they write us about any methods they have found useful in silencing machines without decreasing their output, or methods of preventing reverberation of sounds once started in a room.

Donald A. Laird, Director
Psychological Laboratory,
Colgate University,
Hamilton, New York.

This Month's Amateur's Telescope

OUR telescope-making campaign refuses to die, which is just what we like. Instead, it spreads and gains ground. The number who have taken up this work since the publication in March, 1926, of the SCIENTIFIC AMERICAN instruction book "Amateur Telescope Making," is now well along past 2500, and the interest keeps up at a uniform, steady rate. We expect this "short-lived fad," as it was once dubbed by a doubting Thomas, to outlive



A section of Franklin's original lightning rod

all our editorial staff—and we are not so very antique at that. Here is an interesting letter from a locomotive engineer on the Union Pacific Railroad. He says he thoroughly enjoys making telescopes. So do we.

Telescope Editor,
SCIENTIFIC AMERICAN:

With the "bug" inoculated by the book, "Amateur Telescope Making," I have com-

Mr. Bergstrom's first telescope was small but he found it useful. It is better to start with a modest instrument than to fail with a large one, as a few have done

pleted two reflecting telescopes. The first is small, having a three and one-fourth-inch mirror, the mounting being identical to the one described in Figure 27 of your book, except that a tube was substituted for the long wooden supporting bar. A double lens of one-half-inch focal length—a watch maker's glass—was used for the eyepiece. The instrument gives a wonderfully clear and beautiful view of the moon.

Experience gained on his first telescope enabled Mr. Bergstrom to do his best work on the second [illegible]. And now he is at work on a third, and the end is not yet!

My second telescope has a six-inch mirror, paraboloid and slightly undercorrected. The mounting is made up of two Ford front wheel assemblies secured at the

auto wreckers. This is well shown in the photograph, and I will try to describe it by mail to amateurs who may wish to duplicate it. The declination axis is made up of a one and one half by three-inch pipe nipple, threaded from end to end. A Timkin roller bearing, also secured from an auto wrecker, is employed.

The telescope stand was made up of three quarter inch angle iron and light

A close-up of the two home-made axes of the telescope, made almost entirely of parts recovered from an auto-wreckers junk pile

galvanized sheet metal fastened together with stove bolts. It is thoroughly braced and is very light and rigid.

I think I have found a hobby in telescope making that will stay with me for life. Since beginning this interesting work, my leisure time has not included one dull moment. Every step, beginning with the setting of the handle on the mirror with pitch, until the last touch was completed, was exceedingly interesting. It is a real recreation. At present I have an eight-inch disk on the polishing tool.

I really feel that I owe to you the pleasure I have had with this new hobby. It sure "takes the cake" for keeping up an unabating interest.

H. O. Bergstrom.
P. O. Box 491, North Platte, Nebraska.

The Sport of Model Making

CURIOUS indeed is the psychology which brings recrudescence of various phases of science. Like the child who plays again with some toy that has been put away for a time, with an eagerness as for an entirely new amusement, so we often see the return of interest among the grown-ups for something that has long been considered passé.

Model making as an entertainment flourished prominently some years ago; then practically died out. The last three or four years has witnessed a very decided revival of interest, for besides numerous books published on the subject, we find working models of ships of all kinds; complete locomotives and trains—both abroad and in this country; working models now on exhibition in the west, of an entire line of road building machinery; models of electric-lighting layouts, safety signal systems, et cetera.

It may therefore be of considerable interest to call attention to the illustration which we show of a working model of a locomotive built a number of years ago by C. C. Helmick of Akron, Ohio, from plans published in the SCIENTIFIC AMERICAN. Recently the Assistant Secretary of the Akron Association of Model Engineers, J. W. Neptune, discovered this model in the builder's attic and with his permission rejuvenated and placed it on exhibition.

Length, 41 inches; drivers, five inches; height, 10½ inches; air-brakes on all wheels; weight, 60 pounds; steam pressure, 125 pounds; gage, four inches; uses coal; cylinders, one inch by one and five eighths inches; M. C. B. auto-couplers.

Has the Keenness of Eyesight of Birds Been Exaggerated?

FROM one of our readers, Mr. Frederick Law Olmsted of Olmsted Brothers, the well-known Brookline, Massachusetts, landscape architects, we have received the following inquiry:

Editor, SCIENTIFIC AMERICAN:

The very interesting article by Dr. Eltingham in the SCIENTIFIC AMERICAN for last December on "The Multiple Eyes of Insects" suggests to me the possibility of another article that would be extremely interesting (if you can get the right man to do it) on

This model of the locomotive that pulled the funeral train of President McKinley was built from plans published years ago in this magazine

an allied subject which has caused a good deal of (generally very loose) theorizing: namely, a comparison of the quality of vision of good human eyes with that of certain birds (notably hawks, eagles, and buzzards) as well as with that of insects.

Frederick Law Olmsted.

Although we suspected that the suggestion would prove fruitless, for we believe science has not yet fully investigated the subject of eyesight in birds, we referred Mr. Olmsted's letter to Dr. Alexander Wetmore, Assistant Secretary of the Smithsonian Institution and President of the American Ornithologist's Union. Dr. Wetmore's interesting reply follows:

Editor, SCIENTIFIC AMERICAN:

Vision in birds is remarkable to me for its accommodation that permits, for example, a sparrow to distinguish a seed within an inch of the end of its bill, and at the same time allows it to distinguish a hawk soaring high overhead. Most birds have a distinct faculty for two kinds of vision. One, monocular in which both eyes work independently, and the other binocular in which both concentrate on the same object. There are in most species two distinct centers of sharp vision for these two ...

... where, according to the popular concept, the smallest fragment of food is seen by birds so high in the air as to be practically invisible to humans. During approximately 30 years of observation throughout the New World, from this country south to Patagonia, I confess that I have never seen anything of the kind. It is my candid opinion that vultures soar aloft merely for the pleasure of a joy ride in the ether, and when they are actually hunting for food they are sweeping in great circles near the earth in loops that bring them down within a few yards of any object that seems to promise food. Through this incessant quartering, they distinguish easily, snakes, mice, or dead creatures of any kind and descend to feed. Larger creatures, of course, can be seen from a much greater distance, but I do not place the slightest credence in their seeing small bodies at any great distance.

It has been my common experience when stopping to rest or to examine some bird or other creature that I had shot for a museum specimen, to have, within a few moments, a turkey vulture or even a condor come sweeping overhead looking down curiously to see what I was about. Unquestionably such birds have come to learn that man is an animal to be kept under observation, and that when he stops he is liable to leave behind him something that may serve for food. I have even had the yellow-headed vulture, in the South American Chaco, fly in to alight above me in a heavy forest in which I had momentarily disappeared from view.

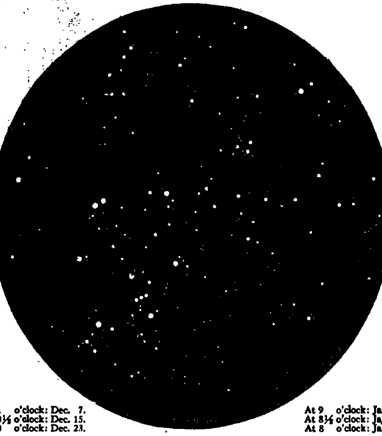
Many vultures are gregarious to a point where they assemble nightly in central roosts from which they spread out to search for food. In their quartering back and ... quently in sight ... when one descends to feed others are soon hurrying to it, particularly to carcasses of considerable size. I do not see in this, however, any indication of the wonderful eyesight usually ascribed to them, but rather merely an example of their careful search for subsistence.

Sincerely yours,

A. Wetmore.

The Heavens in December

By PROF. HENRY NORRIS RUSSELL, Ph.D.



At 11 o'clock: Dec. 7.
At 10½ o'clock: Dec. 15.
At 10 o'clock: Dec. 23.

At 9 o'clock: Jan. 7.
At 8½ o'clock: Jan. 14.
At 8 o'clock: Jan. 22.

At 9½ o'clock: December 30.

NIGHT SKY: DECEMBER AND JANUARY

The Heavens

THE full array of the winter constellations now shines splendid in the southeastern sky. Orion is well up, the line of his belt pointing down toward Canis Major and up to Taurus. Auriga is almost overhead, and Gemini just below on the east. Canis Major is lower, on the right and Leo is rising far down on the left. Between the latter and Gemini is Cancer, with the Praesepe cluster in full view. The Hyades, too, are conspicuous in Taurus, near Aldebaran, as are the Pleiades, a little to the right.

There is not one bright star in the southeastern sky, though the planet Jupiter, by his brilliance, makes up for the lack.

The Planets

Mercury is a morning star all through December. He is easily visible at the beginning of the month when he rises about 5:30 A.M. But long before its close he is lost in the sun's rays.

Venus and Mars are also morning stars. The former rises between 3:00 and 4:00 A.M. and is very conspicuous, but the latter is too near the sun to be easily seen. He is in conjunction with Mercury at about one degree, on the tenth.

Jupiter is in quadrature, east of the sun, on the 18th, and is in sight until midnight.

Saturn is in conjunction with the sun on the third, and is visible only as a morning star at the end of the month.

Uranus is in eastern quadrature on the 22nd and observable in the evening, while Neptune rises about 10:00 P. M. and can be studied telescopically in the morning hours. Ordinarily, to find Neptune's disk, invisible to the naked eye, a six inch reflecting telescope or its equivalent is required, and setting circles must be brought into use. However at the present period Neptune remains close to the first magnitude star Regulus, in Leo, and in same declination. In December, until the 18th, he will be in approximate R.A. 10^h 05^m; Dec. 12°15'. On that date he begins his retrograde motion which lasts until May. Those who hunt for him without circles may observe daily for a period, watching for the slow movement of the planet with regard to the stars.

The moon is in her first quarter at 9:00 P. M. on the 1st; full at 1:00 P. M. on the 8th; in her last quarter at 7:00 P. M. on the 15th; and new at 11:00 P. M. on the 23rd; and once more in the first quarter at 6:00 A. M. on the 31st. She is nearest the earth on the 6th, and farthest off on the 18th. While traversing the zodiac she passes Jupiter on the 2nd, Uranus on the 3rd, Neptune on the 13th, Venus on the 19th, Mars on the 22nd and Saturn as well, and meets Jupiter and Uranus again on the 30th.

There are two eclipses this month—a total lunar eclipse on the 8th, and a partial solar eclipse on the 24th. The former, though invisible in the United States, is to be seen throughout almost the whole eastern hemisphere; the latter is visible only in the Antarctic regions.

It should finally be recorded that at 2:12 P.M. on December 22nd, the Sun reaches its greatest southern declination and enters the sign of Capricorn, and "winter commences."

Applied Science for the Amateur

(Continued from page 544)

peller blades of various patterns. Number 1 is the style used by two early aircraft pioneers, namely, Maxim of England, and Langley of America. This form is easy to make because the rough blank can be sawed out with a straight saw, and the carving itself is simple. Many model makers choose to make their propellers of this blade shape, and when the propeller is carved out, they round off the corners and make a shape resembling that to the right. Other model makers prefer to cut out the desired blade shape in the blank form.

Figure 2 shows the type of blade used by the Wright brothers in their historic airplane, which was the first to carry a man into the air. It is more efficient than the Langely; in fact the Wright propeller may be described as a Langley propeller with one of the corners cut off.

Figure 3 is a blade pattern used a great deal. A study of this form will reveal that it is merely an adaptation of the Wright shape with the corners rounded off. A modification of 3 results in type 4. This shape is very popular with model fliers because it is easy to carve and performs well in the air. Blade 5 is a further modification of 4, and is the shape often used by the United States Navy on their seaplanes. It is quite efficient. Figure 6 shows a type of blade commonly known as the diamond pattern. It is more difficult to carve than the shapes to the left, but the resulting propeller is pleasing in appearance and performance. Figure 7 shows the shape of blade used on the latest metal propellers which have been establishing world's records for performance.

The method of producing an aircraft propeller is as follows: Propellers may be made of any light wood, such as pine or spruce, but for the racing models balsa wood is preferable because of its lightness and the fact that it can be easily worked. A piece of wood is obtained which will be large enough to accommodate the propeller desired. It may be stated that the smallest models require a propeller of not less than five inches diameter and on the largest models it is customary to use propellers of about 12 inches diameter.

The drawing was made of a typical propeller of the shape shown in Figure 4, and the width is based upon a 10-inch propeller. For longer propellers the blade should be narrower and for shorter propellers it should be a trifle wider. In this typical propeller the width of the blade is seven eighths of an inch, and the thickness is five eighths of an inch. This would do for a 36-inch model intended for general flying. If the model is intended for long flights, the pitch of the propeller blades should be increased, which is accomplished by using a thicker blank.

Figure 8 shows a piece of wood intended for the propeller. The model maker draws upon stiff cardboard a propeller blade outline having the distance from the center to the tip one-half of the intended diameter. The center of the propeller blank is marked and a line drawn down the length of the block, as shown in Figure 8. The center of the propeller outline is then placed above the center of the block and pivoted with a pin. Then, as shown in Figure 9, the shape of the propeller outline is drawn on one-half of the block and a mark made on the [illegible] the [illegible] touches the line [illegible] the block. The [illegible] is then swung

around to the opposite end of the block and the mark on the outline and on the block placed together. By drawing around the outline in this second position the shape of the propeller is completed. It is very necessary, when laying out the propeller, to get the two blades diametrically opposite.

The next step is to drill a hole through the center of the propeller. This should be done carefully, making sure that the hole is perpendicular to the surface. In the case of a pine propeller, a drill carefully adjusted should be used, but with balsa propellers the wood is so soft that an ordinary pin pushed through will make a sufficient hole. The ideal tool for cutting out propeller blanks is a band-saw, but as these are only obtainable in established wood-cutting shops, the model maker who has only ordinary home equipment may have to use a hand-saw of the keyhole or coping variety.

Having cut out the plan view of the propeller, we are next concerned with the profile. This may be left rectangular, as shown in Figure 10, or the blades may be tapered either toward the base or from the center, as shown in Figures 11 and 12. Tapering the blade usually imparts to the model greater speed, but if the model is intended for duration it would perhaps be best to leave the propeller rectangular. The cut out blank is shown in Figure 13.

A right-handed propeller with a curved entering edge will be made from this blank. Considerable discussion has occurred in the past on the question of whether the entering edge of a propeller should be curved or flat. Most authorities prefer the curved edge and this preference may be substantiated by the fact that in aircraft, rounded edges produce the best results. On the latest racing planes there are no square edges. Even the connections between the wings and the body are rounded off. As a practical way of deciding the question of round edges versus straight edges, a model maker recently made comparative flights, using in one instance propellers having straight entering edges, and for another flight he used propellers with round entering edges. The round edges achieved the best results.

To carve the propeller, begin cutting as shown in Figure 14, and cut away the wood on the face of the blade leaving the straight edge high and cutting the round edge down to the bottom, producing the result shown in Figure 15. The blade should be slightly cupped, as shown in the end view of the propeller at Figure 16. Turning the propeller around, the opposite blade is carved in the same way and then a small needle is inserted in the shaft hole. Using this as an axle, the propeller is balanced. Should one blade be heavier than the other, additional material must be cut until the balance is perfect. After this, the blades should be sandpapered smooth.

The opposite side of the propeller is cut as shown in Figure 17. This second side should be carefully carved to make sure that no deep cuts are taken which cut through the blade, and yet the blade should be made very thin. The progress in cutting can be watched by frequently holding the propeller before an electric light and noticing by the "pinkness" of the wood how thin the blade is becoming. This thinness should extend to the tips of the blades, which should be about one sixteenth of an inch thick. The thickness of the blade should increase toward the hub, but the outer two thirds of the blade should be mat-

formly thin. When the backs have been carved, the propeller should be again balanced and sandpapered; then the hub should be cut away in order to reduce its weight. The propellers of record-making models have hubs as thin as an eighth of an inch, but for a model maker's first efforts he should have a thicker hub in order avoid the possibility of breakage.

As above stated, the foregoing description applies to a right-handed propeller. A left-handed propeller is made by making the cuts in an opposite manner. A right-hand and a left-hand propeller are shown in Figure 20.

Figure 19 shows how the propeller is fastened to the frame of the model by means of the bearing and shaft, with its washers. As shown, the shaft is passed through the bearing and washers and into the hole. On the outside it is bent at right angles and if the propeller be made of pine it is indented and lashed to the hub. If the propeller be made of balsa, it will be sufficient to cement this bent-over section in proper place.

The type of propeller described may be used on either a tractor or a pusher model. If used on a tractor, the model maker must so place it that it will pull the model forward. If on a pusher, it must push the air away from the model. Figure 20 shows the most efficient method of placing propellers on a twin-pusher model. It is assumed that the propellers have curved entering edges and that the model is being viewed from the rear. The propellers should turn upw and outward to get the best results. should be mentioned that in case twin pellers are used on a model, they sh... weigh the same and should have the same inclination; in fact, they should be identical in push, balance, shape and weight.

As the model maker progresses, he will find out that propellers are a very important part of his model. He will learn that different models require different propellers, and that a propeller which may produce records on one model will not produce equal results on another. Inversely speaking, a model which will not fly with one propeller may fly with another type, so it behooves each constructor to study and experiment in order to obtain the utmost efficiency.

"Breaking In" a Pipe

THE writer has noticed that pipes are now supplied by some firms "smoked," that is, supplied with a shell of charred matter in the bowl as the result of a previous smoking of the pipe by a suction machine.

An old pipe smoker taught the writer, years ago, a simple method of converting a new pipe almost into an old one, in one smoke, by the use of the following successful method:

Mix granulated sugar with water in the palm of the hand to the consistency of a rather thick paste. With the finger dipped in it, coat the inside of the bowl of the new pipe.

Sprinkle tobacco into the bowl *lightly*. Light the pipe and smoke. The hot tobacco chars the sugar, combines with it, and forms a shell at once, apparently cutting off the irritating oils and vapors from the wood. This method makes the new pipe smoke almost like an old one, or at least, much better than one started in the ordinary way.—*Contributed by C. L.*

Learning to Use Our Wings

(Continued from page 540)

is a public thoroughfare controlled and maintained by the government. Even in a small undertaking, flying only two ships daily, 80 percent of the investment may be in planes and motors. Therefore the law of increasing returns does not apply with the same vigor as it does in railroad transportation. Operations must pay from the first, and as operations increase, the reduction in operating costs will not be as large as it would be in the case of a railroad with its huge original investment.

By all those considering air transport from a business point of view, Hanschue's paper is to be carefully read and digested.

A New Landing Light

AFTER the pilot has been guided along his route at night by the huge rotating beacons which are becoming a familiar feature of the American landscape, it is necessary to light either the whole of a field, or at least a long runway so that he may land in safety. The landing light is therefore one of the most important parts of airport equipment. The average amount of horizontal illumination required has been variously estimated at from 0.03 to 0.3 foot-candle.

Opinions of pilots regarding a desirable amount of light are much divided and apparently vary in proportion to their familiarity with certain

Wide World.

An exhibition of the newly developed 10,000-watt incandescent lamp

landing fields. One quarter foot-candle is regarded as a fair average value. Since fields may be as large as three quarters of a mile, and runways may be 3000 feet long, such a degree of illumination calls for a very powerful source. Further, it is necessary that the layer of light be limited to a zone not higher than 10 feet above the ground, so that beams may not dazzle the aviator as he lands. There must also be the greatest reliability in the operation of the light, as a few minutes failure may mean a serious accident.

On the United States Airmail fields between New York and Chicago, 150-ampere arc lights are employed, with a ______ of 115 volts, direct current. Such units are provided with a 180-degree fresnel lens of the marine light-

house type, are elevated about 10 feet above the ground and are housed in small sheds on appropriate sides of the fields. Incandescent lamps, such as the Mazda lamp, have also been used as a light source with this lens. While the incandescent lamp is simpler and more economical to operate, its larger light source produces a greater vertical divergence than the intense, but concentrated arc.

The Sperry Gyroscope Company, and the Westinghouse Lamp Company, working in conjunction, have now produced an incandescent-lamp landing-light which bids fair to challenge the arc, and which has undergone highly successful tests at Mitchel Field, Long Island.

The immense bulbs employed consume 10,000 watts or over 13 horsepower. Large incandescent lamps have hitherto had a relatively short life, whereas the new lamps can be burned for several hundred hours. They are not subject to any troubles in starting or operating and work equally well on direct or alternating current. To concentrate a great length of filament into a small space, a crimped ribbon of tungsten metal has been employed.

Wide World

T[illegible] is used in this housing. [illegible] at the Ford airport at Detroit

The light is provided with a 36-inch, parabolic silvered-glass reflector, and an 80-degree spread lens front door which disperses the reflected beam into a horizontal fan of light having a vertical divergence of only about four degrees. It conforms excellently to the requirement that the light shall spread only 10 feet above the ground. All stray light which might go upwards and interfere with the vision of the incoming pilot is eliminated by a system of semi-circular louvres which are an integral part of the unit.

Flight tests showed that a field could be illuminated for a distance of [illegible] feet. The 36-inch drum has to be ventilated with a motor-driven f[illegible]

There is no doubt that t[illegible] will be of [illegible] aviation.

Industries From Atoms

(*Continued from page* 542)

species were placed in cotton-stoppered, glass vials, and rolled up in rugs, or buried in the stuffing of upholstered furniture. The fumigant was applied by pouring it into a shallow pan near the ceiling of the ult.

"The results indicate that six pounds per 1000 cubic feet of space of the three-to-one mixture of ethylene dichloride and carbon tetrachloride is 100 percent lethal when used in a gas-tight vault, with a tempera- of 85 degrees Fahrenheit and a 24- exposure. The same dosage at 65 degrees Fahrenheit, however, does not give a perfect kill. A dosage of 12 pounds of the mixture per 1000 cubic feet is 100 percent lethal at temperatures above 65 degrees Fahrenheit. For general fumigation work in gas-tight chambers it is recommended that a dosage of five quarts, or 14 pounds of the mixture per 1000 cubic feet be used. In comparison with carbon tetrachloride, the mixture appears to be about five times as toxic at ordinary emperatures.

"All experiments with this mixture indicate that the fumigant has excellent powers of penetration. Insects rolled up in thick rugs and buried in overstuffed furniture are readily killed. In a special test, flour beetles, *Tribolium confusum*, and rice weevils, *Sitophilus orysa*, were sealed up in cartons of cereal: specimens of the Indian meal moth, *Plodia interpunctella*, and the saw-tooth grain beetle *Orysaephilus surinamensis* were buried in boxes of candy and other insects were buried i piles of clothing and rugs. A dosage of 14 pounds of the mixture per 1000 cubic feet at 80 degrees Fahrenheit gave a perfect kill."

Electroplated Chromium

METALLIC chromium can be deposited in a thin film by recently developed methods of electrolysis. The electroplate so produced has many properties which make it valuable to industry. In discussing these in a recent issue of *Industrial and Engineering Chemistry*, the writer said:

"The properties of chromium which make it particularly useful to industry are its extreme hardness and resistance to abrasion and its ability to withstand many of the ordinary agents of corrosion, including oxygen at high temperatures and superheated steam. Not only does the metal itself possess these properties to a remarkable degree, but a comparatively thin electroplate of it on an unresistant base metal imparts these properties to the combination to a useful extent.

"The hardness of chromium on Moh's mineralogical scale is stated as 9, which places it in the class of emery and far above any other known metal. This figure is not necessarily absolute, as the result of a test depends largely on the method of determination used, but the fact remains that chromium is harder than iridium and the hardest of steels. In electroplating it, some variations in hardnes are possible according to the conditions of plating, but it is easily possible to realize its full hardness in a plate. One hears of tests made on very thin plates of chromium, over a soft base metal, which can be broken by a file, but a sufficiently strong base supporting a reasonably thick film will show a hardness greater than many gem stones,

approaching that of sapphire and ruby.

"Related to its hardness, but not necessarily inherent in it, is chromium's resistance to wear and abrasion. Even very thin films exhibit this property to a remarkable degree and metal parts subjected to the destructive forces of sliding wear can have their lives increased many fold by protection with a chromium plate. Such parts as bearings in automotive engines, engravers' plates, and fine gages have had their useful lives prolonged as much as four to eight times by chromium films less than a mil in thickness.

"Chromium is unaffected by the ordinary atmospheric agents of corrosion and retains a brilliant finish although exposed to rain, snow, and sea water. It resists all ordinary acids except hydrochloric and sulfuric, and is unaffected by sulfur compounds generally, including hydrogen sulfide, sulfur dioxide, and those present in petroleum and rubber dough. Molten zinc, tin and brass, ammonia, and the industrial organic acids, except oxalic, do not affect chromium. Its resistance to lactic and acetic acids is valuable. It is not discolored by heating in air up to 800 degrees, Centigrade, and resists physical breakdown oxidation up to 1149 degrees, Centigrade. Its melting point is 1520 degrees, Centigrade.

"Early chromium plates were unsatisfactory in their resistance to corrosion, possibly because of the difficulty of making a firmly adherent plate free from pinholes, a condition obviated by recent improvements in methods of its application. The presence of pinholes is especially to be avoided in a plate on iron as chromium is 'nobler' than iron and its presence tends to increase the speed of electrolytic corrosion of iron with which it is in contact. In general, it is preferred for corrosion resistance to put the chromium on top of a nickel or copper plate to insure protection of the iron and complete adherence of the final protective coating."

Pulp Mill Waste in Tanning

LEATHER prepared by using the waste of sulfite paper mills to replace customary tanning materials has been shown by the Bureau of Standards to be quite as satisfactory as that tanned by the ordinary procedure. The results of an investigation show that this waste material can be satisfactorily used for tanning when blended with other materials such as quebracho wood and chestnut-wood extracts. Thus two old industries may benefit by this use of a disagreeable waste.

Carbon Dioxide, A Disinfectant

THE carbonation of beverages and water has a decided effect in reducing the bacterial content, according to Charles E. McKelvey, research fellow of the American Bottlers of Carbonated Beverages. Mr. McKelvey has conducted an extensive research on the bactericidal action of carbon dioxide at Iowa State College and reports the following conclusions:

"Carbon dioxide has a distinct germicidal effect upon bacteria, the magnitude increasing with the pressure of the gas.

"The effect upon different bacteria varies greatly, the pathogenic forms being killed most easily, and the spore formers resisting [illegible]

"Despite its evident effect as a germicide, the use of carbon dioxide should be pre[illegible]d by all p[illegible]

Commercial Property News

A Department of Facts and Notes of Interest to Patentees and Owners of Trademark Rights

CONDUCTED BY MILTON WRIGHT

Injunction After Patent Expires

A MANUFACTURER gets an injunction against a competitor restraining him from making, using or selling articles which infringe on the patent. Soon thereafter the patent expires, leaving the infringer with a large stock of infringing articles on his hands. There no longer being any patent monopoly, is he free to sell them?

Such was the question put to the Circuit Court of Appeals in the application for an injunction brought by the Fulton Company against Bishop and Babcock Company on a patent Fulton obtained on a thin, flexible metal bellows made from a thin-walled metal tube. An injunction, granted six months before the patent expired, had prevented infringements while the patent was in force, and the application now was to further restrain the infringers from selling articles manufactured in the lifetime of the patent.

The precise point does not seem to have been decided in this country heretofore, and the court drew its precedent from England, quoting Lord Chancellor Lyndhurst, as follows:

"I am of the opinion that the court would interfere, after a patent had expired, to restrain the sale of articles manufactured previous to its expiration in infringement of a patent right, and that a party would not be allowed to prepare for the expiration of a patent by illegally manufacturing articles, and immediately after its expiration to deluge the markets with the products of his piracy, thus reaping the reward of his improbus labor in making it.

"The court would, I say, in such a case restrain him from selling them, even after the expiration of the patent."

Reasoning from this, the court granted the injunction, saying:

"No violation of the patent law comes merely from selling the article after the patent expires; the violation is indirect; the basic reason of the result is that the article itself came into existence in violation of law.

"Its conception and birth were tainted. To permit it to be sold would be to impair the patent grant by shortening its term."

Motes and Beams in Trademark Oppositions

OFTEN, when the registration of a trademark is opposed by another trademark owner, the question will hinge on the validity not of the applicant's trademark, but on the validity of the opposer's trademark. Such was the case recently when the Rubber and Celluloid Products Company, owner of the trademark "Rubberset" for brushes, sought to prevent the Star Brush Manufacturing Company from registering "Rub-R-Tite." In allowing the registration First Assistant Patent Commissioner William A. Kinnan says:

"It is believed plain enough the notation 'Rubberset' is merely descriptive. Anyone at all familiar with these goods and with the constructions of glue or cement-set brushes and with rubber-set brushes would understand the opposer's notation meant that the bristles of the brush were set in rubber. Such a person might not understand the process by which the product was obtained but if, on purchasing a brush so labeled, he found the bristles were set in glue or cement, instead of rubber, he would believe he had been deceived. There seems no other conclusion can be sustained than that the notation is merely descriptive.

"It would also seem proper to hold that even if the notation of the opposer company were sustained as a suggestive trademark, the rights under such mark could not be held so broad as to preclude others from using the word 'rubber' in connection with goods of the character here under consideration. If it is correctly held that the term 'rubber' is public property, then the applicant company has not used it in a manner deceptively similar to the use which the opposer company has made of it."

Do Not Sleep on Your Rights

IF you hold a patent and sit idly by for years and make no protest while others build up a profitable business upon an infringement of your patent, you will not be permitted to recover from the infringers in the courts.

Such is the principle followed by Judge Runyon in the New Jersey Federal District Court in dismissing the suit for infringement brought by the Playograph Company against the Star Ball Player Company. Explaining why he finds the plaintiff guilty of laches, or inexcusable delay, the Judge says:

"The litigation here involved concerns the movable ball feature of the bulletin boards employed to depict in a graphic manner the progress of a baseball game and to show its movements play by play.

Patents Recently Issued

Classified Advertising

Advertisements in this section listed under proper c insertion; minimum number of words per insertion 24, n pany each insertion.

Official copies of any patents listed in this section at 15c each; state patent number to insure receipt of desired patent copy.

Pertaining to Apparel

ATTACHMENT FOR SWEATERS AND THE LIKE—Which can be readily applied to sweaters and similarly knitted garments, to maintain their normal form so as to prevent stretching, and subsequent distortion. Patent 1639928. S. H. Cohen, c/o "Jerry-J." Co., 360 So. Los Angeles St., Los Angeles, Calif.

SHOWER SHAWL—A paper shawl, or cape and hood, adapted to be thrown over the head and shoulders in an emergency to protect the clothes from injury by rain. Patent 1641039. H. Le Beaud, 208 W. 122nd St., New York, N. Y.

METHOD OF VARYING THE SIZE OF GARMENTS.—To make a garment or coat larger or smaller, as required to fit the person for whom it is intended, and to be of further use. Patent 1642627. M. Paley, 66 Spring St., Monticello, N. Y.

Chemical Processes

TIMBER PRESERVATION—For preventing decay of posts buried in the ground, by placing in contact with the buried part pulverulent arsenic-containing material of gradual dissolvability and continuous impregnation. Patent 1639601. H. C. Gardiner, Anaconda, Mont.

PAINT FORMULA—Manufactured from ground scrap rubber a solvent such as rosin, and linseed oil, dissolved by boiling, the product is substantially transparent and forms an undercoat. Patent 1639599. L. Francis, c/o Walsh, Beckman & Ellis, 701 Olympia Bldg, Miami, Fla.

Designs

DESIGN FOR A REFLECTOR—Patent 73351. A. de Lugo and J. W. Robertson, c/o Robertson Metal Arts Co., 157 E. 32 St., New York, N. Y.

DESIGN FOR A BOTTLE OR SIMILAR CONTAINER—Patent 73267. J. I. Poses, c/o Weil, Coursen & Manges, 285 Madison Ave., New York, N. Y.

DESIGN FOR A LIGHTING-FIXTURE CANOPY—Patent 73390. M. Schlepp, c/o Sterling Spinning & Stamping Co., 476 Broome St., New York, N. Y.

DESIGN FOR A BADGE.—Patent 73408. M. I. Gerson, c/o Jack Sherman, Union Taxi Owners Association, 1441 Broadway, New York, N. Y.

Electrical Devices

HOLD-UP ALARM—A foot-operated circuit controlling means by which a merchant when held up may signal for help without the knowl-

"On July 28, 1918, The Baseball Playograph Company, a Connecticut corporation, filed its bill of complaint in this court against the Star Ball Player Company, defendant herein, alleging infringement of the first three patents above noted. An answer was filed and thereafter, for almost six years the suit dragged its way, being successively either dropped from, continued on, or restored to the calendar until, on June 1, 1920, an order was filed dismissing the cause under Rule 57.

"The last of the four patents, known as the Baker patent Number 1171830, application for which was filed November 25, 1912, was issued on February 15, 1916.

"The bill of complaint in the present action was filed June 25, 1923.

"In my opinion, the charges of laches is warranted. In the first place, the existence of the defendant company, as well as that of any of its allegedly infringing devices, was known to Baker, president of the Baseball Playograph Company and inventor of the fourth patent, when the original suit was started, and yet neither that company nor any of its successor assignees did anything decisive for the establishment and settlement of its alleged rights for almost nine years after the original suit was started and for more than seven years after the fourth patent was issued.

"In the meantime, and during all of the intervening period, the defendant company has busied itself openly and with each succeeding baseball season in the exploitation of its product, and the gaining of a market for it.

"It appears to me unjust, therefore, that after so long a period of inactivity, during all of which the various holders of the patent in suit were chargeable with knowledge, the plaintiff should now be allowed to press its suit in an endeavor to nullify the defendant's toll of years. Had the original plaintiff proceeded with its suit in due course, or had a suit been commenced within a reasonable time after the issuance of the fourth patent, the issues might have been long since settled, and both parties left with certain knowledge of their rights and limitations."

Patent Progress in Japan

AN internationally known firm of patent attorneys has just issued a report on the progress of the Japanese patent system in the reign of the late Emperor. The figures are interesting. In 1912 there were 7168 patent applications and 1774 patents. In 1926 there were 12,495 patent applications and 3520 patents. Apparently it was a little easier to get a patent in Japan 15 years ago than it is today. This is evidenced by the decreasing size of the percentage between the applications and issued patents.

In 1912 the mechanical patents numbered 1337 or 75.4 percent of the total, the chemical patents 284 or 16.6 percent, and the electric patents 153 or 8.6 percent. In 1925 there were 2566 mechanical patents or 50.4 percent of the whole; 1409 chemical patents or 27.7 percent; 1113 electric patents or 21.9 percent.

Commenting on the figures the report states:

"It must be noted from the above that the number of inventions of mechanic industries shows no tendency of marked increase, but gradually diminished in percentage. On the contrary, inventions of chemical and electric industries have steadily increased both in number and percentage. Particularly noteworthy is the fact that the number of inventions of chemical industries show an increase during 1915-1918, while mechanic and electric industries diminished. The increase, it is considered, is an outcome of an extraordinary progress of Japan's chemical industries during the World War. As for the invention of electric industries, the number shows an abrupt increase since 1921 and the percentage is only 8.6 in 1912, but 21.9 in 1925, the rate of increase being 115.5 percent. This phenomenon indicates the remarkable development of the electric industries in Japan in recent years."

edge of the bandit. Patent 1639578. S. Steinhardt, c/o A. Steinhardt & Bros., 1373 Broadway, New York, N. Y.

Variable Condenser—In which one of the conducting elements has rolling contact with the di-electric element, affecting a variance in contact, whereby injury to the di-electric is eliminated. Patent 1637646. H. Kimura, 1604 West Jefferson St., Los Angeles, Calif.

Diaphragm for Telephonic Apparatus—For sound sending and receiving, formed of thin discs with registering grooves, and a layer of viscous material interposed, whereby the diaphragm is without vibration. Patent 1640830. G. Lakhovsky, c/o C. Chassevent, 11 Boulevard de Magenta, Paris, France.

Magneto—Characterized by its breaking device, comprising two platinized nonadjustable contacts and a cam capable of determining their separation, and adjustable from the exterior. Patent 1640290. J. E. and S. E. Perisset, c/o C. Chassevent, 11 Boulevard de Magenta, Paris, France.

Hand Lantern.—An electric torch or flashlight so constructed that when the user requires both hands the lantern may be securely emplaced upon a supporting surface. Patent 1641880. G. Cohen, 201 W. 49th St., New York, N. Y.

Lead-in Connection.—Adapted to be applied to the wall of a room whereby a receiving set may be readily connected or disconnected with the ground and antenna wires. Patent 1642618. E. N. Naupin, Fallon, Nevada.

Electrical Binding Terminal.—To which a multiplicity of wires may be connected at the same time, and in which electrical contact between each, and the terminal, will be uniform. Patent 1642042. J. L. Polk, 3 Lake Place, Troy, N. Y.

Of Interest to Farmers

Hitch for Draft Animals—Which affords facilities for connecting the harness of draft animals, one in front of the other, so that both may pull in a substantially straight line. Patent 1639608. C. Hofland, Westhope, N. D.

Means for Sterilizing Cotton and Other Seeds—Which affords facilities for subjecting seeds to the action of live steam, whereby the extermination of insects and germs will be effected without injury to the seeds. Patent 1641097. P. H. Rylander, 209 E. 18th St., Austin, Texas.

Of General Interest

Flexible Waste-pipe Cleaner—Formed of wire coil and having a head mounted to effectively clean a pipe, and prevent kinking, when forced therethrough. Patent 1636766. F. E. Grosvold, 319 So. Farwell St., Eau Claire, Wis.

Handle for Hand Bags and the Like—Consisting of two straps attached at their outer ends, their inner ends joined by a sliding connection, thereby forming an extended handle or lying closely along the bag. Patent 1639674. D. I. Reiter, 100 Fifth Ave., New York, N. Y.

Combined Hair Comb and Cutter—An attachment applicable to any shears and capable of use to enable one to cut one's own hair as in bobbing the same. Patent 1639617. E. Seavey, 359 Pearl St., New York, N. Y.

Marker Block—For use by carpenters, particularly to be employed in marking off spaces on the edges of doors to be mortised for the reception of hinges. Patent 1639083. C. C. Schrader, Hughson, Calif.

Porch Swing—Which affords facilities for making use of motion which results from the operation of the swing to oscillate a fan above the seat. Patent 1640874. 3011 So. 44 St., St. Petersburg, Fla.

Standing Board—A yieldingly mounted platform or more or less oscillatory foot board,

Dilatory Tactics Are Dangerous

SOMETIMES an inventor will keep a patent application pending as long as possible. In such a policy there are certain obvious advantages. Among them may be mentioned the fact that the patent's 17 years of life do not begin to run out until the patent issues. The writer knows of one application which was kept pending 34 years.

That such a policy is dangerous, however, is well illustrated by the recent decision of Assistant Commissioner Kinnan affirming the rejection of appealed claims in the patent of Rutherford Sutherland Smart for an electric heater.

"This case presents an unusual and unjustifiable record," says the Assistant Commissioner. "The construction involved is exceedingly simple and yet the application has been pending nearly nine and one-half years. The reference relied upon was cited in the first action in the case, over nine years ago, and for the last seven years the case has been pending before the examiner, no new references were cited.

"Eight times the examiner has reviewed the claims for this simple construction. He should have closed the prosecution of the case before him years ago. The great amount of work presented to this office precludes such numerous reconsiderations in a case of this character.

"The applicant has no basis for complaint that the examiner finally closed the prosecution of the case before him when he did. The applicant certainly has been given an opportunity to present any and all claims that he reasonably could have desired to have reviewed."

Sales Enterprise

SOME publication ought to run as a regular feature, true-life examples of how wide-awake business men recognize and seize opportunities to increase business. For example:

In the City of Florence, Italy, where the streets are narrow, parking of motor cars has been prohibited. Recently, however, certain public squares were designated as parking places.

One morning at the principal square of the city where about 20 cars can park, it was discovered all the available space was occupied by a complete series of a certain moderately priced American automobile. No salesman was in evidence, but crowds surrounded the fleet of cars all day long—there being no time limit—admiring the cars. Sales of this make of car have been more than satisfactory since then.

for persons who are compelled to stand or walk on a confined area. Patent 1640826. C. V. Jonasson and H. J. Boal, c/o Nultnomah Hotel, 4904 29th Ave., Portland, Ore.

SEAT WITH FOLDING BACK—Comprising a seat and back respectively hinged to the upper end of folding legs, and connected with iron fittings ensuring regidity, and compact folding. Patent 1640273. J. A. Halais, c/o C. Chassevent, 11 Boulevard de Magenta, Paris, France.

NAUTICAL INSTRUMENT—Whereby the latitude position of a ship, or an object on land, may be easily determined by a simpler method than the ones usually employed. Patent 1640828. G. Koffskey, 730 Clouet St., New Orleans, La.

CONSTRUCTION OF REENFORCED CONCRETE FLOORS—Comprising a number of narrow ribs extending across the spaces between solid concrete slabs positioned over the supporting columns, and crossing at right angles. Patent 1641084. W. R. D. Innes, and M. S. Stanley, c/o Messrs. Collison & Co., 483 Collins St., Melbourne, Australia.

CLOTHES-HANGING APPARATUS—Conveniently mounted in the wall of a room, so that clothes may be passed through the opening without necessitating a person leaving the house. Patent 1641106. J. Van Duzer, Firthcliffe, N. Y.

RAT GUARD—Which can be releasably, yet firmly, secured to ship cables of various sizes, without it being necessary to thread the cable through the guard. Patent 1641081. N. Heymann, 2041 Magazine St., New Orleans, La.

WINDOW PORTAL—Which may be inserted in an opening formed in glass or other material, and requires no screws or other securing means to firmly maintain it. Patent 1641044. P. J. Murphy, 1131 Teuton Ave., Bronx, N. Y.

COWL—In which an outlet tube is provided with an opening in its rear face maintained by the action of the wind, and insuring easy movement. Patent 1641060. H. C. Wehrfritz, 204 Claremont Ave., Jersey City, N. J.

SPRAYER—Adapted for use with various types of liquid varnishes, lacquers, enamels and the like, upon surfaces such as motor vehicle bodies and parts. Patent 1641023. R. J. Coffey, 101 Halsey St., Brooklyn, N. Y.

KITCHEN-TUB COVER AND DRAINER—Wherein the upper lid is used as a closure, and the lower depressed foraminous member is used as a drainer for dishes or other articles. Patent 1641061. H. Young, 301 E. 72 St., New York, N. Y.

STEAMING BRUSH—For brushing cloth in tailoring establishments, whereby the steaming and brushing operations are done at one time, steam being projected through the brush. Patent 1641087. I. Kirschenbaum, 223 George St., New Brunswick, N. J.

BRIEF CASE.—Of leather, so reinforced with spring wire, that it will resist permanent distorting strains and will automatically go back into proper shape after twisting or warping. Patent 1641871. S. Solomon, 35 E. 21st St., New York N. Y.

GUARD FOR POISON BOTTLES.—Which may be easily adapted to various bottles, and will prevent the careless or hasty removal of corks or stoppers of bottles containing poisons. Patent 1641897. W. Moses, 1477 E. 92nd St., Cleveland, Ohio.

SHINGLE.—Having locking means integrally formed for cooperating with the complementary portions of overlapping shingles, rigidly securing the projecting free ends against movement. Patent 1641858. J. A. McCarthy, 1325 Buchanan Ave., St. Joseph, Mo.

PHOTOGRAPHIC FILM OR PLATE PACK.—Provided with a protecting sheet and a pulling strip, the protecting sheet being the same length and width as the plate, and the pulling strip twice as long. Patent 1641867. M. and J. Romanowicz, c/o Paget, Moeller & Hardy, Riemergasse 6, Vienna 1, Austria.

NAPKIN HOLDER.—Providing a simple means for dispensing napkins and other paper articles in single succession, as in restaurants and other eating places. Patent 1641841. J. M. Fernandez, 231 E. 95th St., New York, N. Y.

LAMP EXTINGUISHER.—A device for manually extinguishing the flame of a kerosene lamp, also capable of automatic operation, when for example the lamp accidentally falls. Patent 1641254. C. D. Dunbar, Buckeye, Texas.

SHIP'S LOG.—Wherein the power transmitting cable is connected by a single lever with the actuating piston and an accurate reading is secured at different speeds. Patent 1641907. R. Star, 84 Flushing Ave., Brooklyn, N. Y.

DISPLAY BOX.—Comprising two hingedly connected sections of unequal cross sectional dimensions, one of which may be disposed for display when the sections are in open relation. Patent 1641861. S. Moss, c/o Star Case Co., 380 2nd Ave., New York, N. Y.

POCKET OUTFIT FOR THE CARE OF TEETH.—The outfit comprises a tooth brush disposed in a hollow handle, which also houses a suitable dentifrice, all being protected by a cap assuring aseptic conditions. Patent 1642620. J. R. Merrill, c/o Office Picard, 97 Rue St. Lazare, Paris, France.

COMPACT HOLDER AND EJECTOR FOR VANITY CASES.—Wherein the compact is held in place against accidental removal, but in position to be easily swung loose and quickly ejected. Patent 1642611. W. G. Kendall, 118 Market St., Newark, N. J.

MATCH BOX.—Arranged as an article for securing together the ends of a belt for supporting in a convenient position a supply of matches, or other small articles. Patent 1642629. J. Rankin, Louisa, Ky.

BAG RACK.—Which is of simple and durable construction, which has the capacity to handle paper bags of various sizes, and in any convenient arrangement. Patent 1642619. J. Medlock, Grandfield, Okla.

ALL-METAL TELESCOPIC BOX FOR CAMERAS.—More particularly for copying cameras, comprising box-like sections telescopically associated, easily operated for carrying out focusing operations, and will be very durable. Patent 1642651. A. H. Gaebel, c/o Gaebel Corp., 225 Broadway, New York, N. Y.

RE-ENFORCED MINE PROP.—Possessing increased strength over the usual wooden props of equal cross sectional area, being constructed with a metal casing and a central hard-wood core. Patent 1642603. M. J. Conway, 99 South 11th St., Coalesville, Pa.

Hardware and Tools

CORE BARREL.—A sampling or coring device designed to contain and securely hold, while the tool is being withdrawn, a sample of the formation in well drilling. Patent 1640264. O. M. Carter, Scanlan Bldg., Houston, Texas.

DRILLING TOOL.—Whereby samples of the formation may be frequently taken so that the possibility of unconsciously drilling through a producing strata is reduced to a minimum. Patent 1641113. P. Brunt, 42 Grant Road, Addescombe, Croydon, England.

CLEANING IMPLEMENT—A tool so constructed for supporting a mop head that it may be readily manipulated to grip or release the mop head or bundle of rags. Patent 1641034. M. E. Harber, 344 High St., Richmond, Ky.

Heating and Lighting

HEATING AND VENTILATING DEVICE—In the form of a grille supported adjacent a window and against the wall for directing heated air upwardly and outwardly into a room. Patent 1640331. S. R. Lewis, c/o Am. Foundry & Furnace Co., Bloomington, Ill.

STOVE—For burning oil, wherein heat is efficiently generated with economy in the consumption of fuel, convenient control, and safety in the operation of the burners. Patent 1641064. H. M. Britan, Ojus, Fla.

GAS BURNER.—Which thoroughly comingles the gas or other fuel and the air, to produce a highly combustible mixture adapted to generate a maximum amount of heat and little or no deposit of carbon, the burner has reversible jets producing either a laterally or upwardly directed flame. The inventor has been granted two patents 1641274 and 1641275. P. C. Hughes, c/o Hughes Plumbing Co., Tulsa, Okla.

AUTOMATIC DAMPER.—Adapted to be located in an outlet flue pipe as a fuel saver, operating to gradually close as the draft diminishes preventing the escape of gas. Patent 1641375. J. Beaulieu, 351 Union Ave., Lynbrook, L. I., N. Y.

Machines and Mechanical Devices

SCREEN CLEANER—For screens through which spraying mixture of paint or like substance passes, whereby clogging of the screen is prevented by use of a special brush. Patent 1639590. L. O. Corkran, Chesterfield Farm, Rhodesdale, Md.

SHOE-SOLE DRIER—For use in the manufacture of shoes, directing heat to the shoe soles, without subjecting the uppers and entire shoe to the heat. Patent 1639592. L. H. Dastis, 3312 Clarendon Rd., Brooklyn, N. Y.

PLUG FOR OIL WELLS—Having a rubber element which when compressed will rigidly adhere to the wall of a well and prevent flow of water. Patent 1639079. W. C. Cushing, Box 113, Bristow, Okla.

WASHING MACHINE—Having means for forcing water into the clothes, and the cylinder divided in such manner that the weight of lifting the clothes is uniformly distributed. Patent 1639130. L. W. Hamilton, 215 Valentine St., Kenosha, Wis.

WIND

shields to determine the extent of the sail area presented to the wind, and the area shielded. Patent 1640269. H. Ellison, 116 Wellington St., London, Ont., Canada.

TOBACCO DENICOTINING PROCESS AND APPARATUS—By which the nicotine can be easily and quickly extracted up to any percentage desired, the tobacco flavour and quality remaining fully preserved. Patent 1640298. J. Sartig, c/o G. Hirshfeld, Alexandrienstrasse, 134, Berlin, S. W. Germany.

SIGNALING MECHANISM—For use in conjunction with the elevator service in office buildings, for signaling the operator of a car the time to again start, after landing. Patent 1640286. R. A. Neuschotz. 545 W. 111th St., New York, N. Y.

AUTOMATIC LINE INDICATOR FOR TYPEWRITERS—Which requires no adjustment but is automatically operated when the lower edge of the sheet of paper comes to a pre-determined position on the platen. Patent 1640337. G. N. Alworth, 409 No. Chcago Ave., So. Milwaukee, Wis.

TROLLEY-WHEEL RETAINER—An attachment to a portion of the wheel fork arranged to form a guard around the trolley wire and thus keep the wheel in place. Patent 1640304. H. G. Winter. 119 Oakdene St., Pittsburgh, Pa.

GAS-CONTROL COCK—For controlling the flow from a main to a meter, any leakage around the cock, when in closed position, being vented to atmosphere, exteriorly of the building. Patent 1639431. H. B. Hatton, Jr., 423 West Harvard St., Glendale, Calif.

GOLF STROKE REGISTERING DEVICE—By means of which the distance which the golf ball would travel, were it not intercepted in its flight, is made visible by a series of lights indicating the number of yards the ball would have

traveled if struck on the open fairway. A novel mechanism returns the ball to the driver. The inventor has been granted two patents. 1639714 and 1639715. G. I. Thomson, 9041 Commercial Ave., Chicago, Ill.

PASTEURIZING APPARATUS—In which a traveling carrier conveys bottles of liquid through heating and chilling chambers, the heating and chilling being automatically operated as the bottles pass. Patent 1640239. S. Oymaa, c/o H. Irwin, Box 896, Hilo, Territory of Hawaii.

SAFETY ATTACHMENT FOR WASHING MACHINES—Including means whereby the driving mechanism for the drum is rendered active or inactive by the locking or unlocking of the outer casing doors. Patent 1641050. J. E. Gariglio, 730 Henry St., Brooklyn, N. Y.

DOOR-OPERATING MEANS—Permitting of a person effecting an opening or closing of the doors, of a garage or other structure, at a point remote therefrom. Patent 1641067. C. A. Connelly, Marvin Ave., Shelby, Ohio.

METHOD OF AND APPARATUS FOR SETTING PIPE OR CASING AND PREVENTING SEEPAGE AND LEAKAGE IN WELLS—By means of a flexible liquid cement container, of tubular form, encircling the well casing at the point desired to effect cementation. Patent 1641035. G. A. Hero, 329 Schoupitoulas Ave., New Orleans, La.

VENDING MACHINE.—For dispensing boxes of matches or other merchandise, constructed to provide a removal opening at the upper end, in a convenient position, thus eliminating a chute. Patent 1641860. E. Morell, c/o United Cigar Stores Co., 44 W. 18th St., New York, N. Y.

SHUTTLE-THROWING DEVICE.—Wherein the shock of the loom will be readily taken up, and the rapid motion of the core checked at a desired time. Patent 1641882. C. C. Farwell, Groton, Mass.

EGG-MARKING DEVICE.—A printing machine which will conform to curved surfaces, whereby delicate articles such as eggs may be safely printed or impressed with a suitable indicia. Patent 1641238. J. Schierenbeck, 136 Hudson St., Albany, N. Y.

TICKET-DISPENSING APPARATUS.—For holding a multiplicity of tickets in a folded condition and in stack formation, the tickets being presented one at a time for removal. Patent 1641834. J. M. Fernandez, 231 E. 95th St., New York, N. Y.

ORE FEEDING APPARATUS.—For automatically feeding ore to the rotating drum of an ore furnace, together with means for preventing over-feeding by temporarily rendering the mechanism inactive. Patent 1641363. W. H. Parsons, Middletown, Calif.

SPEED-REDUCING GEAR.—Which may be readily adjusted to secure different speeds and transmit substantially any desired power through a belt or other transmitting means. Patents 1641845. T. L. Fitzpatrick, Massena, N. Y.

OIL-REFINING APPARATUS.—A still composed of a plurality of horizontal preheaters for the cracking of heavier hydrocarbons and the production of the more volatile hydrocarbons, such as gasoline. Patent 1641852. H. A. W. Howcott, 820 Kernan Bldg., 317 Florida Ave., Baton Rouge, La.

VALVE.—Adapted to open automatically when the pressure at the inlet reaches a predetermined pressure, which may vary at will within a considerable range. Patent 1641892. F. T. Lane, E. 3253 Pacific Ave., Spokane, Wash.

DEVICE FOR CEMENTING WELLS.—Especially two-string wells, wherein the discharge of the cement is controlled by a float valve which co-acts with a seat arrangement in the well casing. Patent 1641915. A. Boynton, 1800 San Pedro Ave., San Antonio, Texas.

SMALL PRESSING APPARATUS.—More particularly a small pressing apparatus for pressing articles which are long and relatively narrow width, such as neckties, ties and like articles. Patent 1641876. N. Bonsanti, c/o Munn, Anderson & Munn, 24 W. 40th St., New York, N. Y.

CEMENT PLUG.—For closing the bottom of a well casing so that when the casing is lowered into liquid cement, the cement will be forced up on the outside. Patent 1641741. H. A. and C. F. Davis, c/o Cleo F. Davis, 108 North Broadway, Redondo, Calif.

Medical and Surgical Devices

DIATHERMY KNIFE—A combination of an electrode and a detachable blade, by which the destruction of tissue and the removal thereof can be effected simultaneously, without bleeding. Patent 1639996. S. H. Groff, 1160 Magnolia Ave., Long Beach, Calif.

TRUSS.—Having a novel bearing member for exerting pressure on the pad, as well as novel means for adjusting the pad position. Patent 1641389. D. O'Brien, Punta, San Juan, Cuba.

Prime Movers and Their Accessories

INTERNAL-COMBUSTION ENGINE APPLIANCE—Which may be readily attached to any stationary or automotive engine of common use, for preheating, cleaning, moistening and mixing the air, to full capacity or varied degrees. Patent 1641052. L. Rogers, Carson City, Nevada.

ROTARY ENGINE.—In which valves and valve-operating means, crank shafts and connecting rods, are dispensed with, thereby eliminating faulty operations, and reducing vibration to a minimum. Patent 1641911. T. Tschudi, c/o Chevneat Equipment Co., P. O. Box 1383, Paterson, N. J.

Pertaining to Recreation

WATER-SPORT APPARATUS—Which is buoyant to sustain a person afloat assuming a sitting posture, while permitting the use of the legs to propel the apparatus. Patent 1639607. B. L. Henry, c/o E. A. Gainsburg, 302 5th Ave., New York, N. Y.

AMUSEMENT DEVICE—Including a moving frangible target supporting a prize, said target when broken by a projectile, releasing the prize for delivery to a participant. Patent 1639596. A. M. Dritz, 258 5th Ave., New York, N. Y.

JUMPING DEVICE—An elliptical spring device, worn in the manner of a skate, whereby a child is able to jump relatively to great heights and distances. Patent 1638350. G. H. Long, 17 Dundas Drive, Lankershim, Calif.

GOLF-GAME APPARATUS—Employing a checker board embodying features characteristic of golf, certain squares being trapped with bunkers, sand-pits, water hazards, and out-of-bounds simulating a golf course. Patent 1640699. W. Gaston, 160 W. 231 St., New York, N. Y.

CHECKERBOARD—Having novel checker holding means incorporated therewith in such manner that the foldable sections when in folded position house the checkers and prevent loss. Patent 1641104. W. P. Solod, c/o Henry Siegel, 1779 81st St., Brooklyn, N. Y.

Railways and their Accessories

SIGNAL.—For displaying a warning at a railroad crossing, which is automatically positioned by the train approaching the crossing and rendered inoperative after the train has passed. Patent 1641855. J. L. Lamont, c/o Jos. L. Shaw, Atty., Geneseo, Ill.

Pertaining to Vehicles

STEERING DEVICE FOR MOTOR VEHICLES—Consisting of a large toothed ring entirely contained in the vehicle body, and through which the driver's legs may be inserted, said ring engaging a pinion which controls the steering shaft. Patent 1638750. C. Schaeffer, c/o C. Bistry, Boulevard de Strasbourg, Paris, France.

HYDRAULIC SHOCK ABSORBER FOR MOTOR VEHICLES—Comprising a circular drum, and a spindle mounted to project from the center and oscillate therein, may be applied to front or rear axles and springs. Patent 1638777. W. P. Mason, c/o Collison & Co., 483 Collins St., Melbourne, Australia.

AUTOMOBILE LOCK—Especially designed for use on hand brakes to secure the latch rod, and consequently prevent movement of the car by unauthorized persons. Patent 1638688. W. F. Fipps, 3152A So. Compton Ave., St. Louis, Mo.

POWER ATTACHMENT FOR MOWERS—Whereby a mowing machine may be operatively connected with a Ford automobile, so that the parts will function to produce a forward mowing. Patent 1638680. J. A. Cook, P. O. Box 83, Franklin Furnace, N. J.

HEADLIGHT ATTACHMENT—For use on ordinary automobile headlights for preventing the blinding rays thrown in the eyes of approaching drivers, but without dimming the light on the road. Patent 1639600. C. B. Frierson, Box 668, Cleveland, Miss.

DEVICE FOR ALIGNING WHEELS—To be employed in connection with the front wheels of an automobile for disclosing the amount of correction necessary, if the wheels are out of alignment. Patent 1639604. J. H. Gray, 9th and Felix Sts. St. Joseph, Mo.

LOCKING DEVICE FOR MOTOR CONTROLS—For rendering motor control parts, such as the spark and throttle levers, unmovable, especially adapted for use with the steering assemblage of a Ford automobile. Patent 1639612. J. F. Nevius, 957 Caldwell Ave., Bronx, N. Y.

COUPLING—Adapted for use as a connector for a strap or the like with a chain or the like of a draft appliance for a vehicle. Patent 1639609. C. Hofland, Westhope, N. D.

SAFETY APPARATUS FOR VEHICLES—Operable in response to force applied to the bumper by contact with a person, whereby the emergency brake mechanism stops progress, and a guard is simultaneously released. Patent 1640836. J. E. Jufe, 519 W. 139th St., New York, N. Y.

AUTOMATIC STEVEDORE-TRUCK BRAKE—Which will ease the load on an incline, and function to automatically stop the truck, to prevent it running over or injuring the workman, should he fall. Patent 1640808. A. J. Becker. 573 Park St., Upper Montclair, N. J.

WHEEL OR TIRE HANDLING APPARATUS—Which may be conveniently attached to any ordinary mechanical or hydraulic jack, and easily manipulated for the mounting or demounting of wheels or tires. Patent 1640297. F. Rogers, c/o Credit Lyonnais, Paris, France.

VEHICLE LAMP—An arrangement for mounting a pair of headlights on a vehicle and connecting them so that they may be turned simultaneously about a parallel or aligned axes. Patent 164041. J. H. McPherson, 217 Ruben Bldg., McKeesport, Pa.

MIXTURE FOR STOPPING LEAKS—May be poured into automobile radiators and will act quickly for sealing a leak, the composition consists of water, sugar, flaxseed and salt. Patent 1641066. J. D. Campano, Berkeley Heights, N. J.

TRAILER COUPLING.—Wherein means are provided for connecting the engine of the tractor to the coupling mechanism for raising the trailer, when it is desired to uncouple the same. Patent 16781. (Reissue). W. Mayer, 47 Gower St., Forest Hills, L. I., N. Y.

BRAKE.—More particularly a brake for the front or steering wheels of automobiles, either when parallel to the longitudinal axis or turned at an angle. Patent 1641912. G. Walker, 1400 10th St., Huntington, W. Va.

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Lack of space makes it impossible to give many cross-references or to enter a given reference in more than one place. Each article is therefore entered where it is believed it will be most easily found. In every case, the general subject should be sought rather than the supposed specific title of an article. We call special attention to the classifications "Aviation," "Radio," etc., under which many items will be found whose location otherwise would be very puzzling. The asterisk (*) indicates that the article in question is illustrated.

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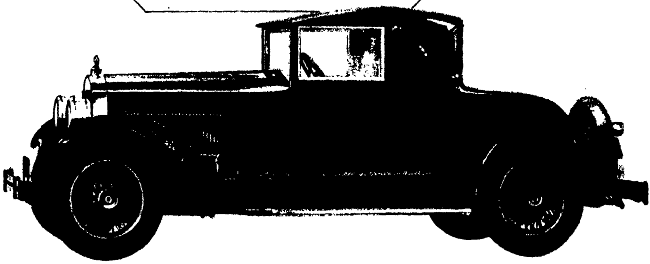

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